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TECHNICAL COLLEGES AND INDUSTRY

AT the Conference on Technical Colleges and Industry in Britain arranged by the Federation of British Industries, and held during May 5–7 (see *Nature*, July 31, p. 210), Sir Arthur Smout strongly criticized the present position of technical education and its subordination to local and party politics. In particular, he proposed the establishment of a Technical College Grants Committee comparable with the University Grants Committee, so as to free the administration and finance of at least the major technical colleges from such influence; this indeed might help to secure the essential academic independence and properly constituted governing bodies for which Dr. P. F. R. Venables pleaded at the North of England Educational Conference held in January. To be successful, however, it might also require the responsibility for technical education, except in so far as training for unskilled or semi-skilled occupations is concerned, to be removed from the Ministry of Education.

Sir Arthur Smout's forthright comments on salary-scales support arguments advanced by representatives of the teaching staff in the technical colleges, and the impossibility of drawing any sharp distinction between technical and technological education is a further reason for some such change. The expansion of technological education in the five centres proposed by the Government will still make it necessary to continue the provision made in the remaining university departments of technology and in the technical colleges. Dr. Lincoln Gorden, in addressing the Union of Lancashire and Cheshire Institutes last October, for example, expressed the view that the expansion of existing university departments, the development of existing colleges of technology and the establishment of one or more independent institutions along the lines of the Massachusetts Institute of Technology, even if pushed to the furthest practicable limits, would not surpass the growing needs. Even if the useful suggestion made by Dr. Venables at the Federation of British Industries Conference were adopted and the use of the term 'technological education' be limited to postgraduate education, the overlap between technical and technological education—and indeed between the functions of the universities and the technical colleges—would not be eliminated; nor indeed may it be desirable that it should be.

Any body responsible for technical education would accordingly necessarily be concerned with technological education, and it should be considered whether the responsibility for both could not be effectively discharged by the technological education sub-committee of the University Grants Committee. Such a step might have the advantage of encouraging parity of status and esteem between the technical colleges and university departments. It should be noted that in arguing again for the establishment of a technological university Lord Cherwell, in his Messel Memorial Lecture on July 14, once more referred

to the lack of esteem which careers in science and technology still receive in many grammar schools and public schools and universities. That contention, however, finds no support in the discussion on higher technological education at the Congress of the Universities of the Commonwealth at Cambridge last year, where it was fully recognized that the universities should play a part in the production of technologists and that technological education must take its place with the other and older disciplines. Admittedly, to do so, universities require a much closer knowledge of the nature and purpose of industry and of the needs of industry in respect of personnel. Moreover, it was recognized there that in technological education we are concerned with the acquisition of knowledge for the purpose of achieving industrial or commercial objectives, rather than, as in a scientific education, primarily with the acquisition of knowledge and the mastery of objectives.

Nevertheless, whether in the university department or in the technical college, the emphasis must be on education, as distinct from training. It is the mastery of theoretical knowledge which later can be combined with skill and experience in applying it to immediate ends; and the training in that process is a function which must largely depend on the co-operation of industry itself. For that reason, an alternative to Sir Arthur Smout's suggestion deserves consideration, particularly in view of the close dependence of industrial development and technological advance on both technical and technological education.

The increasing interest now being taken in the educational responsibilities of the research associations is only one indication of the readiness of industry to associate itself with technical education and training, and has already led to the suggestion that the Advisory Council for Scientific Policy might be the appropriate body for watching over the development of the technical colleges in the national interest. To make that body responsible for the distribution of grants for technological and technical education would involve, however, a major disturbance to the existing arrangements. What is really needed is some sufficiently authoritative body which is competent to formulate a real policy and see that it is implemented, and that the procrastination of the Ministry of Education is no longer tolerated.

Effective means are required of fostering co-operation between the universities, the technical colleges, the professional institutions, the local education authorities and industry and commerce, of formulating policy in place of piecemeal decisions and of implementing it in a way that wins consent. An overall plan for technological and technical education is required to avoid waste of resources and to command approval of the sacrifices which will be involved; but it is equally true that no such plan will work effectively without understanding and co-operation at all levels, local as well as regional. Now that Mr. R. A. Butler has lifted the veil on the Government's intentions, much constructive thinking is required as to the best means of dealing with the many complex issues that arise within the broad framework laid down. Three specific points appear to require early attention, and they are inter-related: the extent to which the training of technicians and technologists can be carried out in industry itself; the balance between research and teaching, in the universities and in the expanded colleges of technology; and the relation between supply and demand for scientists and other graduates. All in turn react on a fourth problem, namely, the supply and distribution of trained man-power available for such developments, quite apart from the question of finance and material resources, and disregarding the situation in regard to technical colleges disclosed by the twelfth report of the Estimates Committee for the session 1952–53 last autumn.

It is to be regretted that the Parliamentary and Scientific Committee has seen fit to publish the memorandum* on higher technological education which it had already drafted when the Chancellor made his statement on July 13, instead of examining carefully the implications of that statement and making constructive proposals to deal with these issues. As it stands, the memorandum is essentially a summary of known views on the expansion of higher technological education, which indicates some of the essential factors but makes no positive contribution for the solution of any of the intricate problems involved. This is particularly true in respect of the reconciliation of clashing interests where the Committee might have been expected to be most helpful. Indeed, the memorandum lacks any appreciation of the fact that the improvement of technological and technical education, urgent and important as it is, will demand sacrifices elsewhere. To be effective, the developments now proposed by the Government will make heavy demands on resources, apart from money, which are already scarce—good teachers, buildings and equipment. At the intake end they affect the redistribution of students over courses; to ensure that the proposed new facilities are fully used when available may entail an educational campaign in the schools and elsewhere, as a recent report from the Advisory Council on Scientific Policy indicated.

It may be necessary, as Mr. F. H. Perkins suggested in a paper before the recent meeting of the Associations of Technical Institutions and of their Principals, to divert a larger proportion of those who have taken classics and the arts courses at school into scientific courses, to place in the technical colleges more of the 'patient plodders' of the present university population, who are regarded by Mr. J. F. Wolfenden as unsuited for a university education and who might develop better in such courses, and to adopt improved methods of selecting and training those who seek a career in science and technology but did not receive a university education. The response to such measures will, however, depend in part on the readiness with which industry absorbs the increased output of scientists and technologists. Any considerable amount of unemployment among

* Parliamentary and Scientific Committee. Memorandum on Higher Technological Education. Pp. 16. (London: Parliamentary and Scientific Committee, 1954.) 2s.

particular types of technologists or scientists when scientific establishments, both government and industrial, cease to expand, and new scientists and technologists are wanted chiefly to replace losses through retirement and like causes, could adversely affect the numbers leaving school prepared to take up careers in applied science.

This aspect of the problem merits much more careful examination than it has yet received. Until much more reliable evidence is available on prospective demand, it would be wise to follow Sir Philip Morris's advice and concentrate on ensuring that talent of varying kinds is given the maximum opportunity to develop according to its bent. That is not merely an argument for a variety of institutions for higher technological education: it is equally a reason for promoting much more effective co-operation between technical colleges, universities, professional institutions, industry and commerce. The establishment of a common field of interest in common problems and common objectives, and a recognition by all concerned that others have their indispensable contribution to make in achieving the desired objectives are the first steps. The Federation of British Industries and the Department of Scientific and Industrial Research have already, through their conferences, done something in this direction; but more is required. On industry, on the universities and on the technical colleges especially, lies the responsibility for seeking urgently to devise appropriate means for closer and more intimate relations while the Government is formulating policy and the means for securing the overall co-ordination of the distribution of resources.

The balance of research and teaching obviously turns in part on this question of supply and demand, but still more on the extent to which we succeed in introducing more breadth into the teaching of science and technology, both at the universities and the technical colleges. It is not a multiplication of highly trained specialists that the nation needs, least of all young men and women who are the creatures of their skills rather than the masters of them. Industry and society need rather more men and women who have been equipped by a broad and humane education with the knowledge, skill and adaptability to seize the opportunities of development that scientific and technical advances offer to industry.

Much that Prof. E. C. Stoner said in a lecture at Leeds on the balance of teaching and research in universities is highly relevant to the question of research in technological colleges. If it is true that more opportunities are desirable for the teaching staff to engage in both research and consulting work, and for a technical college to encourage, in co-operation with industry, a wide range of applied research of high quality, it is not the students only, even postgraduate students, who will profit by engaging in such research. For the good of the community and of themselves, many such would be better occupied otherwise, and this factor should be kept in mind in determining the pattern of expenditure at technical colleges and at universities.

Prof. Stoner estimates university expenditure on research as about 35 per cent of the total, the remainder being broadly on undergraduate teaching. It is arguable whether it should be allowed to run anything like as high in the technical colleges, even if it is admitted that costly large-scale projects in applied research which, as Prof. Stoner points out, would be out of place in the universities, might fittingly be encouraged in the larger colleges of technology where these colleges are suitable equipped. Even so, it is probably true that such projects are more appropriately and conveniently, if not more effectively, carried out by the industries themselves or by research associations. Indeed, the danger of distorting the work and structure of the departments concerned and the unbalancing of their relationship with the rest of the college may well be even greater than in the department of technology of a university, and all the more if the technical colleges show a like caution in accepting candidates for postgraduate research to that which Prof. Stoner suggests for universities, and limit their choice to those who show promise of powers to advance their chosen field farther not simply as assistants but as originators of new lines of thought and investigation.

Any such policy implies a more balanced view of their responsibilities in the development of the young men and women whom the technical colleges educate, such as Sir Charles Morris urged on the universities in his Joseph Payne Memorial Lectures. Such a balanced view is necessary to secure the co-operation, which is so important, between industry, the universities and technical colleges. It could be decisive in determining the distribution of trained man-power available for the development of technological education, whether in the universities or in the technical colleges.

On this last issue the memorandum of the Parliamentary and Scientific Committee seems strangely unrealistic. The memorandum suggests that the universities could increase their output of scientists and technologists without increasing the present total number of students, without detriment to present standards and indeed with some increase in breadth of studies. It nowhere recognizes fully that such a change in balance would make quite appreciable demands for staff as well as buildings and equipment, and would be in competition with the expansion of the colleges of technology. Nevertheless, the report contemplates the expansion ultimately of some twenty such colleges, though admittedly of only "a few" at first, and it pursues the chimera of a new award; 'bachelor of technology' is suggested, without pausing to consider where the teaching staff, for example, is to be obtained, or at what sacrifice elsewhere.

Teaching staff of high standard, academic autonomy, adequate equipment and buildings are the conditions that must be secured before any new award can even begin to win the prestige that will give it any value, and the Committee passes too lightly over the question of co-operation and the means by which it is to be achieved. Its memorandum

gives little hope that any serious attempt is being made to help Parliament to understand clearly the price which has to be paid for the expansion of technological and technical education, or the necessity of regarding such expansion and developments as part of a concerted policy for the promotion of education at all levels, from the university to the schools. A realistic and comprehensive view, however, is essential, both for the formulation of policy and the wise allocation of resources as between the universities, including their technological departments, the colleges of technology, technical colleges and the schools. If the main responsibility in that respect lies on the Government, the implementation of that policy depends on the co-operation and goodwill of industry and commerce, the professional institutions, and the local authorities, as well as of the universities and colleges directly concerned. While the Government has still a long way to go in elaborating policy and allocating resources reasonably, there is much that could be done in the meantime by all such bodies to assess needs and priorities and ways and means of meeting them locally, and in devising appropriate forms of co-operation. Finally, it will be necessary to educate public opinion to hold a higher level of general esteem for careers in technology and to accept the fact that sacrifices will be required in an expansion so vital for the industrial and economic future of Britain.

ORGANIC CHEMICALS

Dictionary of Organic Compounds

The Constitution and Physical and Chemical Properties of the Principal Carbon Compounds and their Derivatives, together with the relevant Literature References. Edited by Sir Ian Heilbron and H. M. Bunbury. Vol. 1: Abadole–Cytosine. Pp. xvi+654. Vol. 2: D.A.–Hystazarin. Pp. xvi+845. Vol. 3: Ibogaine–NW-Acid. Pp. xvi+838. Vol. 4: Obaculactone–Zymosterol. Pp. xvi+694. New and revised edition. (London: Eyre and Spottiswoode (Publishers), Ltd., 1953.) £28 the set.

"LET'S see what Heilbron says about it"; some such words and the rather worn appearance of all the volumes are oral and tacit tributes to the esteem in which the first edition of this work is held. When the original three volumes were published a few years before the Second World War it was planned to issue completely revised editions at convenient intervals. Circumstances ordained otherwise; although a new edition of the first volume appeared in 1943, the text of the other two remained unchanged, except for a slim supplement.

Although during the war years the direction of research was changed, it continued unabated, and in the post-war period the heavy task of revision was undertaken; the result of that labour is now represented by this new edition. The division into four volumes instead of three gives books which are less cumbersome to handle, and, by utilizing a somewhat larger area of the paper, more than two thousand five hundred new main entries have been incorporated with the addition of only ninety additional pages; indeed, in inches of shelf space, there is practically no change. It is claimed that the literature up to the end of 1950 has been covered, and there are occasional references up to 1953.

The subject of nomenclature is a difficult one, and no particular system has been followed in its entirety; indeed, it is stated that that which is employed in the original publication has generally been given preference. The order in which substituents are listed is different from that formerly used by the Chemical Society, and for convenience it is given in some detail in the introduction to each volume. To have adopted the current alphabetical order would have incurred extensive revision and considerable delay in publication, but it is to be hoped that it will be followed in future editions; the few rules are not difficult to learn, and there is then no need to search a list for the relative position of substituents.

The prefixes cyclo- and iso- are treated as integral parts of names. There is much in favour of this action for the former, because it does not indicate isomerism; but with the latter it means that in comparing properties of, for example, butyl compounds, three are grouped together while the fourth is in another volume. In acyclic acids, the carboxyl group is generally regarded as a substituent, so that 2- and 11-hydroxypentadecanoic acids appear as 1- and 10-hydroxypentadecylic acids respectively; in contrast, 15-hydroxypentanoic acid is listed as 15-hydroxypentadecylic acid. It would seem preferable to adopt the latter numbering throughout so that the same numbers would be used irrespective of whether the name is trivial or systematic. As a minor point, there is lack of uniformity in naming the long-chain olefines—for example, nonene, decylene, tridecene, tetradecylene, octadecene.

For the monoethers of ethylene glycol, one is referred, for example, to 2-hydroxydiethyl ether and 2-hydroxyethyl butyl ether. Such compounds would be more neatly named on the lines of 2-ethoxyethyl alcohol or, even better, 2-ethoxyethanol; the esters of these ethers, for example, the acetates and phthalates, could be named accordingly and are, indeed, of sufficient importance to be listed individually. Such well-established names as carbromal and leptazol are not mentioned at all, the compounds being listed under their foreign names. Mepacrine is referred back to atebrin, and chloramphenicol appears in its own right.

The selection of data which can be quoted with full confidence is very difficult because of the many divergences in the literature. Prof. J. Timmermans, in his recent book on "Physico-chemical Constants", has surveyed some of the ground, and it is of interest to note that an ambitious plan is on foot in the United States to review and assess critically data for chemical compounds generally on the lines of the American Petroleum Institute's Research Project 44, dealing with hydrocarbons.

In this "Dictionary", alternative data which cannot be rejected forthwith are usually placed in brackets. For many hydrocarbons, work by the petroleum interests, both in Britain and in the United States, has reached the stage where some of such values can be discarded. For other types of compounds, there is also some room for improvement. Since 1930, there have been recorded several sets of values for density and refractive index of cyclohexylamine, reasonably concordant among themselves, but very appreciably different from those quoted. Again,

there are several records of these two properties for di-*n*-butyl ether and *n*-butyl propionate, for both of which density at 0° C. alone is given, that for the latter compound dating from 1886. The preferred melting point for *m*-hydroxybenzaldehyde is evidently that of Jowett (1900), who later identified his product as *p*-hydroxyacetophenone; there is ample corroboration of the bracketed value.

Generous use of cross-references avoids duplication of entries with corresponding danger of discrepancies. This has, however, occurred with some of the sulpha drugs and their acetyl derivatives; some of these are also listed as the *p*-aminobenzenesulphonyl derivatives of the heterocyclic amines with melting points which differ by up to 8 deg. C.

A particular feature is the inclusion of a large number of organic compounds of natural origin; but asarinin, stevioside (of interest for its sweet taste) and dihydronorguaiaretic acid (NDGA) are three such products which appear to have escaped the net. Di*tert*-amyl peroxide is listed (under A, contrary to the declared naming of 'double' derivatives) but not the commercially important *tert*-butyl compound.

These various observations must not be taken to imply that the "Dictionary" is bristling with inaccuracies and omissions. They merely show that the editors of books of this kind can never sit back with the comfortable feeling that their work is completely satisfactory; there is always some dusting and polishing to be done. The reviewer will continue to use the "Dictionary", as a first source of information about compounds, except those newly described, with the assurance that, more frequently than not, the search will not be in vain.

B. A. ELLIS

LINEAR OPERATORS

Linear Analysis

Measure and Integral, Banach and Hilbert Space, Linear Integral Equations. By Prof. Adriaan Cornelis Zaanen. (Bibliotheca Mathematica: a Series of Monographs on Pure and Applied Mathematics. Volume 2.) Pp. vii+602. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1953.) 38 florins; 76*s*.

Linear Operators

Spectral Theory and Some Other Applications. By Dr. Richard G. Cooke. Pp. xii+454. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1953.) 52*s*. 6*d*. net.

THE general theory of linear operators is mainly a creation of the present century; it originated in the work of Hilbert and Riesz on the theory of integral equations and its extensions, and assumed its modern abstract form in the 1920's in the hands of Banach, von Neumann and Stone. The past twenty-five years have witnessed its growth into the wide-ranging subject known to-day as functional analysis, which may be described as the application of the methods of topological algebra to problems in the theory of functions.

Each of these two books is concerned with certain aspects of this now enormous field. They have a small amount of basic material in common; but their aims are very different. Prof. A. C. Zaanen is mainly interested in topics related to the classical theory of linear integral equations, whereas Dr. R. G. Cooke's principal aim is to acquaint his readers with the spectral theory of self-adjoint linear operators in Hilbert space.

Prof. Zaanen's book begins with an account of the Lebesgue integral on a general measure space, and continues with a detailed discussion, not only of the L_p spaces but also of the less familiar Orlicz spaces. We next find a description of the structure of Banach spaces and Hilbert space, and an outline of the theory of bounded linear operators, including the Banach–Steinhaus theorem and the closed graph theorem. In order to avoid using the axiom of choice, Prof. Zaanen does not prove the Hahn–Banach theorem on the existence of linear functionals in its most general form, but he shows that it can often be dispensed with; for example, the whole Riesz–Schauder theory of compact (or completely continuous) linear operators is obtained without appealing to it. The Dunford spectral theory is outlined; but there is no account of the spectral theory of general self-adjoint operators in Hilbert space. The applications of the Riesz–Schauder theory to integral equations receive very thorough treatment, the Fredholm theory is extended to a wider class of integral operators than usual (those that are completely of finite double norm), and a very detailed discussion is given of various classes of symmetrizable integral operators.

The book is too long and detailed to be suitable as a first introduction to the subject; but it will be an indispensable work of reference for these aspects of functional analysis. Particularly welcome are the numerous illustrative examples, to most of which are attached either hints for solution or references to the original literature.

Dr. Cooke's book is a successor to his "Infinite Matrices and Sequence Spaces", published in 1950. The first five chapters contain an introduction to Hilbert space and its applications in quantum mechanics, and a very full account of the spectral theorem for hypermaximal (or self-adjoint) linear operators, both bounded and unbounded. A number of the known proofs of the theorem are given in detail. The remaining two chapters deal with topics having little direct connexion with the first part of the book. Chapter 6, on projective convergence in matrix spaces and rings, is a pendant to the author's earlier book, and describes some recent investigations on linear operators in sequence spaces. Chapter 7 is on Banach algebras; it contains a useful account of the Gelfand representation of a commutative Banach algebra by functions on the space of maximal ideals, and its applications to the proof of Wiener's theorem on the closure of translations and his Tauberian theorem. Other topics included are the spectacular and powerful Weierstrass–Stone theorem on uniform approximation to continuous functions, the theory of Radon measures, defined as linear functionals on a class of continuous functions, and an application of the theory of Banach algebras with an involution to the proof of Bochner's theorem on positive definite functions.

Much of the material in this book has hitherto been scattered in the periodical literature, some of it being available only in Russian, and the author has performed a useful service in collecting it together. Dr. Cooke writes as an analyst for analysts; the emphasis throughout is on analytic techniques and applications, and the algebraic structures tend to remain in the background.

F. SMITHIES

British Journal of Applied Physics

Edited by Dr. H. R. Lang. Vol. 4, 1953, and Supplement No. 2: "Static Electrification"—a Symposium held by the Institute of Physics in London on 25, 26 and 27 March, 1953. Pp. vi+391+(supplement iv+104). (London: Institute of Physics, 1953.) £5 11*s*.

VOL. 4 of the *Journal of Applied Physics*, the monthly journal of the Institute of Physics, is the bound volume for 1953 and contains fifteen special articles and reports, three conference reports and sixty-five original contributions, in addition to a supplement in which are reprinted the proceedings of a conference on static electrification held at Bedford College, London, during March 25–27, 1953. In the three conference reports the proceedings are summarized of the conference on electron microscopy in Bristol during September 1952, the fortieth anniversary celebrations of the discovery of X-ray diffraction in London during October 1952 and the conference on the optical and electron-microscopical properties of textile fibres in Manchester during October 1952. The special articles include the address of Sir John Cockcroft, given at the Bournemouth convention of the Institute on May 29, 1953, dealing with recent advances in nuclear physics; the application of digital computing techniques to physics, by R. A. Brooker; recent developments in magnets and magnetism, by Prof. W. Sucksmith; scientific applications of high-speed rotation, by Prof. P. B. Moon; and scintillation counting and its medical applications, by Prof. W. V. Mayneord.

The supplement on static electrification, after a brief foreword by N. Clarke, the deputy secretary of the Institute and conference secretary, contains the opening address, delivered by Prof. F. A. Vick, in which a brief but clear outline of the theory of contact electrification is given. This is followed by twenty-three papers, with discussions, which are grouped under the four headings of general principles, and useful applications, of generation and dissipation of static electricity, electrostatic machines and harmful static electrification.

The editor and advisory committee must again be congratulated for the excellence of production of Vol. 4 and for the high general standard they maintain in the *Journal*.

A Text-Book of Metallurgy

By A. R. Bailey. Pp. viii+560. (London: Macmillan and Co., Ltd., 1954.) 30*s*. net.

IN these days any attempt to write a general text-book on an applied science such as metallurgy is fraught with difficulties arising primarily from the continued rapid expansion of the technology and the further elucidation of the underlying scientific principles. In this case the author has succeeded in producing a very readable survey of most branches of metallurgy without neglecting many recent important developments.

The book falls broadly into three sections—physical metallurgy; ore dressing and metal extraction; fabrication and testing—which are encompassed in just over five hundred pages of text, so it is obvious that most subjects are considered only at an elementary level. Nevertheless, the treatment of the subject-matter is balanced and provides for the first-year degree student a general vista of the subject which is so desirable before he proceeds to more advanced studies. The book's role as a stepping-stone is enhanced by the excellent additional reading lists at the end of each chapter, which are thoroughly up to date. The illustrations are profuse and of good quality; Fig. 274 is unfortunately upside down, so that the liquid metal apparently defies gravity. The examination questions set by various examining bodies are a useful ancillary. The book is a commendable addition to metallurgical literature and deserves to be read by many students. R. W. K. Honeycombe

Cathodic Protection of Pipelines and Storage Tanks

By V. A. Pritula. Pp. vi+160. (London: H.M.S.O., 1953.) 10*s*. net.

THIS book is a translation from the Russian, its publication being arranged by the Department of Scientific and Industrial Research, which recommends it as a practical manual and a text-book on the subject of cathodic protection of pipelines and storage tanks. It was originally published in 1950 by the Chief Petroleum Marketing Organization of the Russian Ministry of the Petroleum Industry and appeared in a series of petroleum and mined-fuel literature.

The purpose of the book is to describe the investigation of the problems of electrical protection of metallic pipelines and storage tanks against underground corrosion. The various types of corrosion are specified, and the fundamentals of the new method of cathodic protection are outlined. The basic principle is to protect the entire surface of the equipment cathodically by connecting it to a source of d.c. potential and forming an electric circuit the anode of which is a specially earthed electrode which becomes corroded during the process. The anode is usually made of scrap metal.

Full details of the investigation, design and operating conditions for the practical use of cathodic protection, together with explanatory circuits and diagrams and much numerical data, are given in the twelve chapters and two appendixes in the volume. The bibliography refers only to what appear to be Russian periodicals.

Theory of Superconductivity

By M. von Laue. (Translated by Lothar Meyer and William Band.) Pp. x+140. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 4 dollars.

THE title of this book is somewhat misleading, since it is not so much a general account of the phenomenon of superconductivity as a comprehensive development of the ideas, originally due to F. and H. London, concerning the nature of the equations governing the supercurrent. In view of the very slender experimental evidence in support of the exact form of the London equations, it may perhaps be questioned whether it is in the best interest of the subject to regard them with such confidence in their correctness as Prof. M. von Laue displays. If they eventually are shown to be correct, he will undoubtedly have performed a valuable service in investigating so fully their mathematical and physical consequences; but there is a genuine danger that his authority, and that of other theoreticians, will serve to stifle the critical experimental investigation which this branch of the subject urgently demands, and cause the London equations to be treated with more respect than any tentative theory deserves. It is, no doubt, an advantage to English-speaking readers to have this book available in translation; but since its main interest lies in the mathematics, it cannot be supposed that the advantage is very great. A. B. Pippard

THE PHYSICS OF THE SOLID STATE

FOLLOWING the meeting of the General Assembly of the International Union of Physics in London in July, a number of scientific meetings were held to take advantage of the presence in Great Britain of the delegates to the Assembly from overseas. Of these, two were about the physics of the solid state; one at Bristol sponsored by the Union and with an attendance of about three hundred and fifty had as its subject "Defects in Crystalline Solids", and one directly afterwards in the Department of Metallurgy of the University of Birmingham was on the "Mechanical Effects of Dislocations in Crystals".

The idea of the Bristol Conference was to include two subjects which at first sight appear widely separated, but which are becoming more closely related. The first of these subjects was dislocations in their more chemical aspects. It was desired, for example, to discuss their relation to vacant lattice sites and to diffusion; their role in crystal growth and in accelerating precipitation and also their influence on semi-conductors. But questions concerned with their movement and with the mechanism of the formation of slip bands were reserved for the Birmingham Conference. The second subject was the use of electron and nuclear spin resonance in the investigation of defects in solids. On this subject an impressive series of papers was given by Kittel, Kip, Bloembergen, Slichter and others from the United States and also by representatives from Great Britain.

In addition to the X-ray camera, the optical and electron microscopes, radioactive tracers and all the other techniques used in this field, microwaves have quite suddenly, in the past two or three years, become a tool of major importance. Thus, for example, the electric quadrupole moment of the nucleus makes it possible in suitable cases to determine the value of the gradient of the electric field (dE/dx) at any lattice point where the nucleus is situated. In a pure crystalline substance of cubic symmetry this is, of course, zero, but not in an alloy. Dr. Bloembergen, of Harvard, outlined how in dilute solutions of zinc in copper it is possible to evaluate the contribution to dE/dx separately from the nearest, the next nearest neighbours and so on. Such measurements promise to be of the greatest importance for understanding the forces between atoms in alloys. It has also been possible to measure the density of dislocations in cold-worked substances by their effect on the breadth of the resonance line.

Another important effect is that described by Slichter; the broadening of the magnetic resonance line due to a nuclear spin is much reduced if the atom changes its position in a time small compared with the period of the radiation used. This is because the broadening is mainly due to the interaction with the spins of neighbouring nuclei; and it is, so to speak, averaged out by the movement of the nucleus from one lattice point to another. By this method it has proved possible to measure coefficients of self-diffusion in solids without the help of radioactive isotopes, and results were quoted for the alkali metals.

With regard to the rest of the Conference, there were many papers on the effect of irradiation by fast neutrons and other fast particles, and their effect in producing defects such as F-centres. Prof. R. Hilsch, from Göttingen, spoke on the occurrence of a high concentration of defects in metallic and non-metallic films evaporated at the temperature of liquid helium, and the surprising amount of recovery which takes place when the temperature is raised to that of liquid hydrogen. There was much discussion of networks of dislocations in solids, which can be made visible by the formation of various types of precipitate along them. In fact, the role of dislocations in accelerating precipitation seems firmly established, though the exact mechanism by which it does so is less clear. They apparently act as centres for the nucleation of precipitates.

But perhaps one of the most important properties of dislocations which has recently been brought to light is the ease with which foreign atoms can move along them. As explained by Prof. R. Smoluchowski (Pittsburgh) and by Turnbull (General Electric Schenectady), the activation energy for diffusion along a dislocation is the same as that for diffusion in a grain boundary at which there is a large change in the orientation of the crystal planes. Boundaries at which the change of orientation is small can, as is well known, be analysed into rows of dislocations, and for these the rate of diffusion of radioactive isotopes or of impurities depends on the direction. Thus for a boundary which consists of a row of edge dislocations, the diffusion is fast in the direction in which they lie, and slow when they have to move from one dislocation to another.

It is clear that the ease with which foreign atoms diffuse along grain boundaries and dislocations, which can at the same time move about, plays a large part in allowing precipitation and age-hardening at temperatures at which normal volume diffusion would not be possible. Dr. J. H. Hollomon suggested that the formation in aluminium–copper alloys of the plates of mono-molecular thickness known as Preston–Guinier zones is due to dislocations moving through the grains and sweeping up the copper, which quickly diffuses along the dislocation to be left behind in one of these plates. Since most energy is released by this process when the plates form on the (100) planes, this is the direction in which the dislocations move.

On the subject of crystal growth, Hollomon showed a film of the growth of cadmium iodide crystals suggesting that in the early stages these crystals might well grow without the help of screw dislocations, but that the dislocations on which the well-known spirals are centred are formed when two crystals the orientations of which do not quite fit join together. Dr. J. W. Mitchell (Bristol), who was responsible for the scientific and social organization of the Conference, showed a series of slides which demonstrated that silver halide grains in emulsions owe their triangular or hexagonal shape with the (111) faces exposed to a particularly stable arrangement of three dislocations meeting in a point and lying parallel to the flat surfaces of the crystal.

The papers given at this Conference will be published by the Physical Society.

Turning now to the Conference at Birmingham, organized by Prof. A. H. Cottrell, this dealt in the main with the mechanism of work-hardening and formation of slip lines, and with the production of vacant lattice sites by moving dislocations. There

seems now to be a fair amount of agreement about many features of this process. For example, it is generally assumed that slip has its origin in Frank–Read sources; it is not now believed that the speed of moving dislocations is great enough for important dynamic effects to occur involving the kinetic energy of a dislocation, and Dr. J. D. Eshelby (Birmingham) presented a new paper on this point. Everyone was agreed on the importance of the fine slip lines (about 10 μ long and around 100 A. high) first observed on many metals by Wilsdorf (Pretoria), and that one of the main mechanisms of work-hardening is the elastic interaction between the dislocations which produce this fine slip; this is very much as envisaged in the paper which G. I. Taylor published in 1934. There was much less agreement on the cause of the slip bands which can be seen under the optical microscope and which are much longer. The case of alpha-brass, however, is particularly instructive, and was discussed by Dr. J. C. Fisher (General Electric, Schenectady). Here no fine slip was observed by Wilsdorf, and single crystals of this alloy show very little hardening, at least so long as slip is confined to one set of planes. This shows that the dislocations on neighbouring coarse slip lines are too far away from each other to interact strongly. Fisher's explanation of the absence of fine slip and the conspicuous coarse slip in this alloy is that there is a certain amount of short-range order, which has to be destroyed over a plane when a dislocation moves across it and which therefore hinders its motion. Once a dislocation has moved along a plane, however, others from the same source can follow it under the influence of a much lower stress.

Another mechanism of hardening and also of resistance to flow in annealed metals is the work which must be done to push dislocations past screw dislocations which cut the slip plane. When this occurs, a 'jog' is produced in a dislocation line, and this needs a certain energy. This mechanism of resistance to flow is expected, like the resistance due to locking by impurities, to show a strong dependence on temperature; that due to the elastic interaction of dislocations (G. I. Taylor's mechanism) is not. Cottrell showed some curves giving as a function of temperature σ/G for copper work-hardened at the temperature of liquid air; σ is here the flow stress and G is Young's modulus. This quotient except between 200° and 270° K., is quite independent of the temperature. In this narrow range, however, there is a rapid slope, and Cottrell assumes that here only is this cutting mechanism, which he calls the effect of the 'forest', the one that determines the strength. He also determines from the behaviour in this range the energy of a jog; for copper it is about 4 eV.

It was particularly emphasized by Seeger (Stuttgart) that the jog energy in aluminium is much lower, perhaps 0·5 volt. This is because in face-centred cubic lattices the dislocations split into two half dislocations separated by a stacking fault. At a jog the two halves must be brought together again, and the energy required to do this is the greatest part of the energy of a jog. Now it is characteristic of monovalent metals that the energy of a stacking fault, as of a twin boundary, is very low; there is no contribution from interaction between nearest neighbours, and little from the electrons at the surface of the Fermi distribution due to the fault in the reflecting planes. Therefore the separation between the halves of the dislocation is large, and the work required to bring them together is large, too. For zinc and aluminium it is much less, thus providing rather convincing evidence that the behaviour of electrons near the boundary of a Brillouin zone does provide a sort of long-range force between atoms that are not nearest neighbours.

According to Seeger, many of the differences between aluminium and copper are to be associated with this large difference in the energy of a jog. Mechanical recovery and polygonization are believed to be dependent on the process known as 'climb', when a dislocation gives off or absorbs vacancies. But it can only do this at jogs, and so, if the jog energy is low, climb and recovery without recrystallization can take place at low temperatures, as is the case for aluminium.

Dr. P. L. Pratt (Birmingham) and Dr. J. C. Fisher (General Electric Company, U.S.A.) emphasized that the dislocation forest is responsible for one kind of 'river line' marking observed on cleaved crystal faces. New river lines begin at places where the advancing crack crosses a region of localized plastic deformation or a low-angle boundary. A crack must develop a step whenever it cuts through a screw dislocation, and elementary river lines thus produced run together to form large steps. The cleavage stress is increased due to the extra surface exposed on these steps. Dr. Fisher mentioned an interesting consequence of this effect. The surface area associated with the river lines increases as r^3, where r is the radius of a radially expanding crack, and not as r^2. —This upsets the Griffith criterion for a critical crack size. Previous treatments have deduced a critical size by balancing an r^3 elastic energy term against an r^2 surface energy term; but in circumstances where the above r^3 surface term predominates over the r^2 one, there will not be a critical crack size, and cracks of all sizes will grow at the same critical stress.

N. F. Mott

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

THIRD CONGRESS

THE Third Congress of the International Union of Crystallography was held in Paris, at the Sorbonne, during July 21–30 and was attended by more than seven hundred members, representing some twenty different countries, including, it is gratifying to report, the U.S.S.R. This large membership raised several problems, particularly concerning the number of papers offered; these numbered about six hundred and were divided into groups of about ten, which were presented in seven parallel sessions. Since this system would normally give opportunity to members to attend only those sessions in which they were particularly interested, several survey papers were offered in addition. In this way, members were able to keep in touch with progress outside their own particular specialities. Aid in the choice of sessions was given by an 84-page booklet containing résumés of all the papers to be read.

It is naturally impossible, in this account, to deal with the whole of the Congress. Even had it been physically possible for a single person to be present at all the sessions, he could not have been expected to cope adequately with all the mathematics, physics, chemistry, mineralogy, metallurgy, biology and

crystallography that would have been presented to him. The study of crystals is affecting intimately developments in many subjects; but in this article the writer will attempt only to direct attention to what seem to him to be the main lines of advance in the study of the solid state. A large number of papers were concerned with the details of crystal structures; these obviously will have to be ignored.

Crystal-structure Determination

The theory of methods of crystal-structure determination is at an interesting stage. At one time it was thought that, since the relative phases of the scattered beams could not be determined experimentally, it was impossible to devise a direct method of producing an image of a crystal structure. About six years ago, it was shown by D. Harker and J. S. Kasper, of General Electric, U.S.A., that the absence of negative electron density imposes certain conditions which, in some problems, enables the phases to be determined directly. This approach has led to many new ideas, and there is some possibility, according to J. Karle and H. Hauptmann, of the Naval Research Department, Washington, D.C., that a direct solution of *all* centrosymmetrical problems is possible. This view has been challenged by V. Vand and R. Pepinsky, of the Pennsylvania State University, and by M. M. Woolfson and W. Cochran, of Cambridge. It will be interesting to look back in a few years time to see how the subject has developed.

Meanwhile, although direct methods have produced several new structures, the main advances have been made rather by standard methods—Patterson synthesis, isomorphous replacement and 'heavy' atoms. Mrs. D. Hodgkin, of Oxford, described a partial solution of the structure of vitamin B_{12}; the molecule contains about a hundred atoms, almost three times as many as the most complicated molecule that has yet been dealt with successfully. Similar methods combined with the Fourier-transform concept have also enabled Sir Lawrence Bragg and M. F. Perutz, of Cambridge, to report some success with hæmoglobin, the molecule of which contains about ten thousand atoms. Unfortunately, the Fourier projection obtained, having a resolution of only 4 A., is not particularly clear, and some intense study will be required before any reliable deductions can be made from it.

This work illustrates the difficulty of studying such compounds by X-ray diffraction. There is still much rather subjective argument, and more evidence of the Bragg–Perutz type is needed to decide between the individual opinions concerning the nature of the protein structure.

Fine Detail of Structures

As experimental methods have improved, it has been found possible to distinguish more detail in the images of crystal structures. J. M. Robertson, of Glasgow, first showed that hydrogen atoms in organic crystals could be detected, and the difference synthesis of W. Cochran put this work on a sounder footing. Anisotropy of heat motion can also be measured, and further progress should enable electron distribution in bonds to be detected.

Methods other than X-ray diffraction can be used for detecting hydrogen atoms. Electron diffraction has provided some promising results, particularly in the hands of Z. G. Pinsker, of the U.S.S.R.

Low-temperature Studies

Room temperature is rather an arbitrary level at which to take X-ray photographs, and several different laboratories are working intensively on apparatus for cooling crystals to low temperatures. There are several reasons for this work: first, one can investigate compounds which are liquid at room temperature; secondly, there are many phase transitions below room temperature; thirdly, greater accuracy of co-ordinates can be obtained when heat motion is reduced; and finally, more detail for determining crystal structures can be obtained (although this may be regarded as a mixed blessing !). I. Fankuchen, of Brooklyn, gave a summary of methods that have been devised for taking photographs of crystals at liquid-nitrogen temperature. So far, most work has been concerned with the first two headings, but there is promise that the other two will also be developed.

Methods of Computation

Much of the work so far dealt with requires extensive calculations. Punched-card machines have been greatly used; but the greatest development since the last Congress has been in the use of electronic digital computors. In Britain, the most important machines are at Manchester and Cambridge, and work on these machines was reported by D. W. J. Cruickshank, of Leeds, and A. S. Douglas, of Cambridge. The former was chiefly concerned with the determination of fine structural detail, and the latter with direct methods of structure determination.

Diffractometers

As more complicated crystals are tackled, the mere process of amassing the diffraction data becomes formidable, particularly now that three-dimensional methods are so much used. Photographic methods can barely cope with the problem, and Geiger counters, coupled to recording apparatus, are becoming increasingly popular. Much ingenuity has been applied to this work, and it is to be hoped that soon some standard form of apparatus will be produced; at present there seems to be a gap between the people devising such apparatus and those who are working out complicated structures.

Neutron Diffraction

Despite the smallness of the number of atomic piles, the results of neutron diffraction are increasing rapidly. Having the experience of X-ray diffraction as a background, the workers in this field have made great progress, both in supplementing X-ray work in, for example, the investigation of superlattices and the detection of hydrogen atoms, and in discovering new phenomena such as antiferromagnetic structures, which cannot be found by X-rays. Most work has been done on powders, but a promising start has been made on single crystals; such crystals have still to be rather large, but it seems likely that rapid progress in the use of much smaller crystals will be made in the future. An instructive account of recent work was given by H. A. Levy, of Oak Ridge.

Crystal Growth

Emphasis on the crystalline state has stimulated work on the way in which crystals grow. F. C. Frank, of Bristol, presented an entertaining film showing the development of spiral growths in

crystals. Many such examples are known, and in some quarters the process is believed to be a general one; there are, however, still some people who believe that it occurs for a few crystals only.

Crystal Imperfections

The existence of growth spirals implies that crystals containing them are imperfect, and indeed it has been known for a long time that perfect crystals would not diffract X-rays in the ways observed. The study of imperfections by means of X-ray diffraction is, however, difficult; it depends upon secondary effects not easy to interpret. B. E. Warren, of Massachusetts Institute of Technology, gave a general account of the investigation of one type of imperfection—order–disorder changes in alloys. These changes may be regarded as producing an imperfection based upon a perfect lattice and so should be easier to consider than imperfections of the lattice itself; much theoretical and experimental work has been done, but Warren maintained that the physical interpretation of the results is still obscure.

The conference gave a general picture of the consolidation of existing methods and rapid development of new ones. There seems to be a thriving future for the subject of crystallography, applied to many different branches of science. Much ingenious apparatus was shown in the accompanying exhibition.

In some ways, however, regret must be felt for the departure of the days when an individual worker could make an X-ray tube, construct a simple diffractometer, buy a set of Fourier strips, and produce contributions of real value to the subject. Nowadays, he appears to need an electronic computor, or at least a punched-card machine, some complicated diffractometers and a Geiger-counter outfit. The only steps in the opposite direction seem to be those which make use of optical analogies, introduced by G. von Eller in Paris and by the writer in Manchester. Crystallography will take its own course; but it will be a pity if it follows nuclear physics as a subject which can be studied only at centres large enough for complicated and expensive apparatus to be available.

A Congress of these dimensions could not have been easy to organize. It would have been better if there had been fewer papers; but granted the necessity for accepting all the papers offered, the organizers are to be congratulated on a most successful outcome of their efforts. H. Lipson

OBITUARIES

Sir Lewis Fermor, O.B.E., F.R.S.

The death of Sir Lewis Leigh Fermor on May 24 removes one of the most distinguished geologists who have worked in India during the present century, and his passing at a time when there was still much for him to do is a severe loss to Indian geology.

Fermor was born in London on September 18, 1880. He was educated at Wilson's Grammar School, Camberwell, and was awarded a National Scholarship to the Royal College of Science in 1898. Hoping to secure a post at the Royal Mint, he took his A.R.S.M. in metallurgy. However, at the invitation of Prof. J. W. Judd, he became a student assistant in geology while working for his B.Sc., and it was Judd who persuaded him to apply for one of three vacancies in the Geological Survey of India before he had completed his B.Sc. course. He was duly appointed in 1902, along with G. E. Pilgrim and J. M. Maclaren, and thus went to India primarily as a trained metallurgist, a fact that undoubtedly influenced the course of his geological work in India.

Soon after his appointment to the Survey, Fermor was deputed by Sir Thomas Holland to report on the manganese ore deposits of the country. Holland never anticipated that the investigation would be so detailed or so prolonged. But the resulting memoir was not published until 1909, and it extended to 1,294 pages. It was by this monumental work that Fermor became best known outside India. It included not only a detailed account of all the deposits, with a discussion on their mode of origin, but also important observations on the methods of mining, in which the pitch of the folded rocks was shown to be an important controlling factor. The field-work had also brought to light six new manganese minerals: hollandite, blanfordite, winchite, vredenbergite, sitaparite and juddite, while a seventh mineral, fermorite, was afterwards named after him.

On the completion of this work, Fermor was placed in charge of a party deputed to carry out a systematic survey of the Archæan rocks of the Central Provinces, and he himself surveyed a tract of country between Nagpur and Chhindwara, mapping the rocks in a more detailed manner than had ever before been attempted. The work was interrupted by the First World War, when his services were first lent to the Railway Board in connexion with the exploration of the Bokaro–Ramgarh coalfields, and later placed at the disposal of the Indian Munitions Board. In recognition of this work he was made an O.B.E. in 1919. After the War, work in the Central Provinces was resumed, and Fermor's own portion was completed in 1926. Unfortunately, administrative and other duties prevented the publication of this fine piece of work, though a summary of it was given in his later memoir on the correlation of the Archæan rocks of India.

Work of economic importance that Fermor accomplished during the same period included examination of the Singhbhum and Sikkim copper deposits, the iron ores of Ratnagiri and Goa, the Korea coalfield, the chromite deposits of Baluchistan and Singhbhum, and mica in Ajmer and Orissa.

In 1913 he had published a paper on "Garnet as a Geological Barometer". This was the starting point of a theme that was to recur more than once in his writings; for it led him to the conception of an infra-plutonic zone in the earth's crust composed of eclogite, which he considered to be responsible for the explosive nature of deep-focus earthquakes by the exothermic change of garnet to less dense minerals, for isostatic adjustments in the earth's crust, and for the high fluidity of the lavas of fissure eruptions. He also believed that the chondrules of stony meteorites had once been garnets. His views on these matters were elaborated in a series of lectures that he delivered to the Indian Association for the Cultivation of Science as Ripon professor for 1937, entitled "The Role of Garnet in Nature".

Before he retired from India, Fermor began the writing of a memoir that was to be an attempt at correlating the ancient schistose formations of India. After giving a general discussion on the factors to be considered in effecting a correlation, he had planned to give a summarized account of the geology of the

eight Archæan provinces into which he divided India and Burma. Of this plan only the general discussion and about a quarter of the account had been published by 1940, and other commitments prevented the completion of further sections before his death. Thus a work that would have been of the greatest value to geologists in India has been left largely uncompleted.

In the Geological Survey of India, Fermor was promoted to the grade of superintending geologist at the early age of thirty. Though he first officiated as director in 1922, it was not until 1932 that he was substantively appointed to the post. It was unfortunate for him that his period of office coincided with a period of financial stringency in India. This compelled him to reduce the staff of his Department, and prevented him from planning the work of the Survey as he would have liked. In other directions, however, he was able to render service to India, in particular by the part he played in helping to bring into existence a national scientific academy for the whole of India at a time when conflicting interests were tending to divide scientific India. This was effected by the formation of the National Institute of Sciences of India, of which he became the first president in 1935. During the same year he was president of the Royal Asiatic Society of Bengal, while earlier he had been president of the Mining and Geological Institute of India in 1922, and general president of the Indian Science Congress in 1933. To each of these institutions he delivered original addresses that indicated the wide scope of his outlook. He was elected a Fellow of the Royal Society in 1934 and the honour of knighthood was conferred on him on the eve of his retirement after thirty-three years service.

Though he retired from official service in India in 1935, he continued to play an active part in scientific matters. Perhaps the most important of these was his visit to Malaya in 1938 to report on the mining industry of that country. This report must have proved of the greatest value when the time came to reconstruct the country after the Second World War.

On retiring to Bristol, Fermor took an active part in local scientific life, and became president of the Bristol Naturalists Society in 1945 and 1946. Finally, he was elected president of the Institution of Mining and Metallurgy for the year 1951–52, the subject of his presidential address being "The Mineral Deposits of Gondwanaland".

From the time that he first went to school until he left for India, Fermor's education cost his father little, for both at school and at college, by hard work and ability, he won scholarships that paid for his school and college fees. No doubt it was due to this that he was able throughout his life to apply himself with great concentration to the task in hand, while it may also have been responsible for the relatively spartan life that he led. In later years he mellowed, and the patience and tact that he displayed at the time of the formation of the National Institute of Sciences of India revealed to many a new aspect of his character, and won him many friends.

W. D. West

Dr. Saul Dushman

By the death of Saul Dushman on July 8, the General Electric Company of Schenectady has lost one of a small group of scientists who became world-famous and who established the scientific traditions of the Company's research laboratories—the group which included W. D. Coolidge, Irving Langmuir and W. R. Whitney.

Dushman was born on July 12, 1883, in Rostoff, Russia, and his family migrated to Canada in 1892. They settled in Toronto, and when Saul Dushman left the high school there in 1900 he had the best scholastic record ever achieved in the province of Ontario. This won him the Prince of Wales Scholarship at the University of Toronto, where he obtained his A.B. degree in 1904 and Ph.D. in 1911. Soon afterwards he joined the Research Laboratory of the General Electric Co. and remained on its staff until his retirement thirty-seven years later. He was assistant director from 1928 until 1948.

His early work was on physico-chemical problems; but at the suggestion of Dr. Langmuir he changed over to experimental and theoretical work on thermionic emission, to which branch of physics he soon made important contributions. In 1923 he applied the theory of the vapour-pressure constant for monatomic gases to the derivation of an expression for the constant A_0 of Richardson's equation, which differs only by a factor of $\frac{1}{2}$ from the expression accepted to-day (electrons were not spinning in 1923 !). On the experimental side, with various colleagues he determined the thermionic constants for a number of pure metals and also for metals covered with adsorbed layers.

This work led Dushman to take an interest in vacuum physics, an interest which persisted to the end of his life. He wrote a short book on the subject in 1922, upon which many of us were brought up, and in 1949 there appeared his monumental volume of 882 pages on the same subject. Throughout the book Dr. Dushman's wide personal experience in the field is evident, and his early interest in physical chemistry coloured his choice and treatment of various topics—as indeed it did in his work on thermionic emission. The book will long be a memorial to his encyclopædic knowledge of his subject, his enthusiasm and his desire to serve others.

His colleagues in the laboratory remember him also for his deep interest in human beings, his friendliness and, again, his desire to serve. Physicists all over the world will join with them in paying tribute to his memory.

F. A. Vick

Dr. K. T. Compton

Karl Taylor Compton was born on September 14, 1887, in Wooster, Ohio. He received his bachelor's and master's degrees from the College of Wooster, where his father, a Presbyterian clergyman, was dean and professor of theology. Compton spent the first part of his academic life doing research and teaching physics. He was awarded a doctorate at Princeton in 1912 and, after teaching for two years at Reed College, Oregon, returned to Princeton in 1915, where he remained until 1930, becoming chairman of the Department of Physics in 1929. His numerous papers covered a variety of physical topics, including ionization of gases, soft X-rays, spectroscopy in the extreme ultra-violet, fluorescence and dissociation of gases, electric arcs and other types of gas discharge and photoelectricity. His contributions in spectroscopy and thermionic emission were recognized by the award of the Rumford Medal of the American Academy of Arts and Sciences. In 1927

he became chairman of the Division of Physics of the National Academy of Sciences and was elected president of the American Physical Society.

He was a great teacher with a marked ability to inspire young men. To this skill was added a natural humanity and directness which brought forth the best in all who came within his influence. He brought these great personal qualities to the Massachusetts Institute of Technology, which he served as president during 1930–48 and then as chairman of the Corporation. Building on the sound traditions which he found in the schools of engineering and architecture, he added a school of science, greatly developed the graduate school and brought a humane and liberal spirit to its teaching of science, engineering and management.

Compton gave his time and energy freely in government service in capacities too numerous to mention in any detail. He served in the Signal Corps during the First World War and was chairman of the Science Advisory Board (1933–35) appointed by the President of the United States to advise on the better use of science in commerce and government. As a member of the National Defense Research Committee during the Second World War, he was responsible for American radar development. In the early stages of the War he was a member of the Baruch Rubber Survey Committee and at its end was in the Philippines directing the field service of the Office of Scientific Research and Development. His advice was sought after the War on the evaluation of atom bomb tests and other aspects of atomic energy, and he served as chairman of the Research and Development Board of the National Defense Establishment. He was awarded the Medal for Merit in 1946 for his distinguished war-time services.

He served numerous institutions and companies as director or trustee, including the Ford, Rockefeller, Nutrition and Sloan Foundations and the Research Corporation.

Compton's qualities and experience were recognized in Great Britain. He was Pilgrim Trust Lecturer of the Royal Society in 1943, became an honorary Fellow of the Imperial College of Science and Technology in 1949 and received an honorary degree at Cambridge in 1952. He became an honorary C.B.E. in 1948. A few weeks before his recent death he was advising the Parliamentary and Scientific Committee on Technological Education.

Compton received the enthusiastic support of his colleagues in his great achievements at the Massachusetts Institute of Technology. He was in a large measure responsible for the atmosphere of comradeship, vitality and quiet confidence which permeates its staff and student body. His selflessness, his nobility and his true appreciation for others were an inspiration, and his wisdom and stalwart common sense were sure guides in the growth and changes which he fostered. He understood and did his best to achieve the conditions in which scientific work and learning could flourish. At the same time, he was deeply conscious of the responsibility of scientists and technologists to the community.

The loss of this sturdy, generous and inspiring personality will be felt keenly not only by his friends and his Institute, but also by a world grappling with the many problems posed by modern technology.

W. R. Hawthorne

NEWS and VIEWS

Broadcasting Arrangements for the British Association Meeting at Oxford

The presidential address by Dr. E. D. Adrian to the British Association in Oxford on September 7 will be broadcast in the Home Service and on television. Conferment of honorary degrees on this occasion will also be televised, as well as two important talks by eminent speakers on September 2 and 3 and the service from Christchurch Cathedral on the 5th. A summary will be presented in the Home Service on the 8th. Viewers will first see on September 1 the Convocation in the Sheldonian Theatre at which honorary degrees of doctor of science will be conferred by the vice-chancellor, Sir Maurice Bowra, on Sir Ben Lockspeiser, secretary to the Committee of the Privy Council for Scientific and Industrial Research, Sir John Lennard-Jones, principal of the University College of North Staffordshire, and Sir Harold Spencer Jones, the Astronomer Royal. The proceedings will be explained by Richard Dimbleby. The producer is David Martin. Following this ceremony will come the speeches of welcome from the Vice-Chancellor and the Mayor, and then the presidential address by Dr. E. D. Adrian. The first part only of the address will be televised; but listeners to the Home Service will hear the whole of it.

On September 2, in a talk on "Physics and the Future", viewers will see Prof. P. M. S. Blackett discussing the growing impact of physics on our present-day life, and the following day Prof. C. D. Darlington talking about "Genetics and Man" and dealing with some recent advances and future work in this field. Both talks will have illustrations and demonstrations; they will be introduced by Peter Parker, who will also report for television on each day's activities during the meeting. The producer is George Noorhof. The service in connexion with the meeting on Sunday morning, September 5, at Christchurch Cathedral, will also be televised. There will be three processions: that of the Vice-Chancellor, proctors and beadles, of the Mayor and Corporation, and of the officers of the British Association. The preacher will be Prof. Leonard Hodgson, regius professor of divinity; the First Lesson will be read by Dr. Adrian, and the Second Lesson by the Dean, the Very Rev. John Lowe, who will conduct the service. At the end of the meeting, in a Home Service programme on September 8 called "Scientists in Session", some of those present will give their views and impressions by recordings made in Oxford the previous week.

New Chief Scientist of Ministry of Fuel and Power: Mr. K. T. Spencer, C.B.E.

Mr. K. T. Spencer has been appointed chief scientist of the Ministry of Fuel and Power in succession to Sir Harold Roxbee Cox. Born in 1898, Mr. Spencer served as an officer in the Royal Engineers in the First World War and afterwards graduated at the University of London. He entered the Scientific Civil Service in 1923 and spent twelve years at the Royal Aircraft Establishment, Farn-

borough, in the branch dealing with problems of aircraft design and safety. In 1935 he was transferred to the Air Ministry in London, and up to the outbreak of war took part in the organization of the research, development, production, and safety certification of civil aircraft of all kinds. He went to the Ministry of Aircraft Production on its creation in 1940, and throughout the War was concerned with the expansion of research and development activities here and in Commonwealth countries. Mr. Spencer was a member of the first Brabazon Committee, whose recommendations shaped the first post-war generation of civil air-liners. Towards the end of the War he was seconded to the Air Registration Board to help them build up the technical organization needed to discharge civil aircraft certification duties delegated to them by the Secretary of State for Air. In 1946 he served for six months as an international Civil servant with the Provisional International Civil Aviation Organization in Montreal, and set up their Airworthiness Section. Later he went to New Zealand with a United Kingdom Civil Aviation Mission, led by Sir Frederick Tymms, invited by the New Zealand Government to advise them on aviation matters. He joined the Ministry of Fuel and Power in 1950 as deputy chief, under Sir Harold Cox, of the Scientific Division that had been set up in 1948.

Bacteriology at Belfast: Prof. G. W. A. Dick

Dr. George W. A. Dick, of the scientific staff of the National Institute for Medical Research, Mill Hill, has been appointed to the chair of bacteriology in The Queen's University of Belfast. Prof. Dick, who is thirty-nine, graduated from the University of Edinburgh in 1938 and gained his M.D. in 1949, when he was awarded a gold medal for his thesis. He served with the Royal Army Medical Corps during the Second World War, mainly in Africa with a mobile bacteriology laboratory, and was promoted to lieutenant-colonel in 1945. Having acquired an interest in viruses and rickettsiæ, Prof. Dick was appointed in 1946 to the staff of the Virus Research Institute, Entebbe, Uganda, and there he made valuable contributions to knowledge of yellow fever and some of the recently isolated African viruses. During 1948–50 he held a Rockefeller Foundation fellowship, working at the Rockefeller Institute, New York, and later in Baltimore, largely on poliomyelitis. He then returned to Entebbe and acted for a time as deputy director before going to England in 1951 to the National Institute for Medical Research, where for almost three years he has been working in the Department of Bacteriology and Virus Research, chiefly on hepatitis. Prof. Dick has published forty papers, almost all on viruses. He has lately been appointed joint secretary of the Medical Research Council's Poliomyelitis Committee.

Olaus Wormius (1588–1654)

Olaus Wormius (Ole Worm), who died at Copenhagen three centuries ago, on August 31, 1654, is an interesting example of the seventeenth-century polyhistor, whose fame and authority were as great in his own country as they were abroad. Of Dutch descent, he was born on May 13, 1588, at Aarhus in Jutland, where his father was burgomaster. He was educated at the Gymnasium in Lüneburg, studied theology at Giessen and Marburg, medicine at Strasbourg and at Basle under Caspar Bauhin, and at Padua under Fabricius and Giulio Cassério; after visiting Montpellier and Paris, he took his doctorate at Basle in 1611. Having practised in London for a time, he was appointed professor of Greek and of philosophy at the University of Copenhagen in 1613, and in 1624 succeeded his brother-in-law, Caspar Bartholin Primus, as professor of anatomy and of medicine. Bauhin had inaugurated the Paduan tradition of anatomy at Basle, and Bartholin and Worm took it to Denmark. An able and enthusiastic teacher, Worm was also five times rector of the University of Copenhagen, and physician to King Christian IV. He made no original discoveries in science, though his name was attached by Bartholin to the Wormian bones in the sutures of the skull, which were familiar to the ancients and were also described by Eustachius. Known as the 'father of Danish archæology', Worm compiled six volumes of runic inscriptions, "Monumenta Danica" (1643), and founded a collection of natural history, ethnographic and archæological objects, which after his death passed into the possession of the Cabinet of Curiosities at Copenhagen. His son Willum, professor of medicine in the University, edited the catalogue of the museum in 1655, and he was succeeded in the chair by his son Ole.

Energy Transfer in Hot Gases

The sixth in the series of twelve conferences which were held at the United States National Bureau of Standards during 1951 to mark the fiftieth anniversary of its establishment consisted of a symposium on energy transfer in hot gases and dealt with the problems of radiation from flames and hot gases and the basic and physical mechanisms governing energy transfer in these media. The proceedings of the symposium have now been issued in book form (Circular 523, March 10, 1954; pp. 126. Washington, D.C.: Govt. Printing Office; 1.50 dollars). The contents consist of sixteen scientific papers covering many different aspects. A. G. Gaydon deals with processes of electronic excitation in relation to flame spectra; G. A. Hornbeck and R. C. Herman indicate the importance of using low-temperature, high-intensity sources for the study of polyatomic flame spectra; S. S. Penner, M. Gilbert and D. Weber summarize recent work on high-resolution spectra of hydrocarbon flames in the infra-red between 1 and 2·6 μ using lead sulphide photoconductive cells; and S. S. Penner gives an outline of basic theoretical relations used for calculating the infra-red emissivity of diatomic gases. The present position of the theory of flames, by B. Lewis, is a more general survey of the subject in which fields that require further basic study are indicated. A paper on some reactions of atomic hydrogen in flames, by J. R. Arthur and D. T. A. Townend, is a summary of methods of detecting the presence of atoms in flames and includes a description of some of the experiments conducted at the British Coal Utilization Research Association, Leatherhead. The concluding article in the volume is a brief account by H. K. Sen of an astrophysicist's concept of temperature.

Strength Properties of Plywood

In Bulletin No. 29 of the Forest Products Research Laboratory, Princes Risborough, the strength properties of plywood are considered in "Comparison of 3-Plywoods of a Standard Thickness, Part 1", by W. T. Curry (pp. iv+10; London: H.M.S.O., 1953; 1*s.* 3*d.* net). The methods described in the bulletin

are used to determine the bending, tension, compression, shear and impact strength of plywood. The results obtained from tests on twenty-five different species of 3/16-in. three-plywood are included. A comparison of the strength properties of the various species is shown in block diagram form with the names of the twenty-five plywoods used. The results indicate that Canadian birch plywood possesses the greatest shear strength. Those experimented with were species of the genera *Terminalia, Catostemma, Berlinia, Betula, Bursera, Octomeles, Daniellia, Cistanthera, Aucoumea, Ocotea, Khaya, Afrormosia, Protium, Sterculia, Mimusops, Mora, Tarrietia, Araucaria, Calophyllum, Pterygota, Gonystylus, Shorea, Parashorea, Sterculia* v. *rhinopetala* and *S. oblonga*. It is stated that Part 2 of the bulletin will cover investigations on the effect of the shape and thickness of the veneers used in the construction of plywood upon its strength and it will be issued separately when results are available. The object of the whole investigation is to obtain strength data which will allow the comparison of plywoods made from various species of timber and the derivation of working stresses.

Radioactive Tracers in Plant Nutrition

R. P. Martin and R. Scott Russell have reported on the effect of radiation from phosphorus-32 on the growth and phosphate utilization of barley seedlings maintained in water culture (*J. Exp. Bot.*, **5**, 91; 1954). Concentrations of carrier phosphate ranging from less than 0·01 to 31 p.p.m. phosphorus were employed for varying periods. It was observed that between experiments there were wide variations in the nature and extent of the effects of radiation. An increase in the proportion of the absorbed phosphate translocated to the shoots, and the reduction of root weight, were the most consistent symptoms. While severe injury was characterized by a reduction in both growth and phosphate absorption, intermediate levels of phosphorus-32 on occasion caused increases in dry weight, in nutrient absorption, and in the development of lateral meristems. The reduced metabolic activity of root meristems is considered to be the primary effect in the syndrome of radiation injury. Although injury is due to the accumulation of phosphorus-32 in meristematic regions, no close correlation could be shown between its extent and the level of radiation received by the meristems. The inaccuracy of present methods for estimating the levels of radiation to which tissues are exposed has complicated the investigations of this subject. It appears, however, that the injurious level of radiation may vary from less than 10 to more than 40 rep. per day when the treatment period is 5–7 days. If active accumulation of phosphate occurs, the meristems of plant roots may receive this dosage when treated with more than 5 μc. of phosphorus-32 per litre for periods of six days. The authors discuss the extent to which the effects of radiation may complicate the interpretation of the results of plant physiological investigations.

Forestry in Nigeria: Annual Report for 1951–52

The political and administrative changes which are taking place in some of the Colonies of the British Commonwealth are having their inevitable repercussion on the Forest Departments. Nigeria is now divided into three largely self-governing regions, termed Northern, Eastern and Western, which are united under one Central House of Representatives and a Council of Ministers. Thus, as is indicated in the annual report of the Forest Department for 1951–52 (pp. 38. Lagos: Government Printer; London: Crown Agents for the Colonies; 1953; 9*d*. net), the Department becomes a regional matter and, accordingly, it, though nominally still a unit, has been split into three more or less independent sections under a Chief Conservator. At the centre, as the adviser of the central government, is an Inspector-General whose functions are to see that the Regions are carrying out a central policy, to act as a co-ordinator between the Regions, to advise on distribution of staff, for whose discipline, promotion and so forth he is largely responsible and to be the general representative of Nigeria in forestry matters. The present report, written by the Inspector-General, states: "All powers under existing legislation, save for such central concerns as control of exports or the appointment of staff, have been transferred to the Regions". This removal of function from the centre applies to the policy, too, and where the ultimate decision regarding dereservation of any parts of the forest estates was specifically vested in the Governor, it now lies regionally with the Lieutenant-Governor concerned. On the subject of the size of the forest estate, it is pointed out that the "overall percentage falls far short of what the optimum of a Forest Estate in this or any other country should be". The report deals with the forest administration as a whole—the main features of the regional reports. The Forest Research Branch, as also the Forest School, remains under the Inspector-General; the work of the former is becoming increasingly important.

Bird Preservation

The report for 1953 of the International Committee for Bird Preservation directs attention to the fact that the Committee has now been in existence for thirty-one years and gives many examples of the ready co-operation existing between the various national sections; the success of the international conference on oil pollution of the sea, held in London in October last year, is a striking example. In addition to the urgent question of oil pollution the British section has also been engaged in work in connexion with new legislation for the protection of birds. Early in the year a number of complaints were forwarded to the British section concerning a measure it was proposed to bring into force in Cyprus under which the use of bird-lime for catching birds would be permitted. The British section pointed out to the Secretary of State for the Colonies that the practice had been condemned by almost every country in Europe, and its prohibition was contained in the International Convention for the Protection of Birds, which was signed *ad referendum* in Paris in May 1950 by representatives of twelve different countries. The matter was settled satisfactorily.

During the year the Scottish Ornithologists' Club undertook to make an investigation into the effect of herring gulls on other species, and appointed Dr. J. A. Gibson to take charge of this work. This is part of a scheme which was initiated at a meeting in Sweden in 1950 when it was decided to make a yearly survey of the numbers and details of herring gull colonies in the countries bordering the North Sea, with observations of the effects of these birds on other species, and records of the measures taken to control their numbers and the results obtained. Detailed records are being kept in Denmark, Germany

and Holland; but the problem is far more difficult in the British Isles. The report also contains further details of the inquiry into status of the wildfowl of Europe.

Museum Techniques

Several interesting papers are contained in the April issue of *Conservation* (1, No. 3; 1954), the journal of the International Institute for the Conservation of Museum Objects. Mr. W. G. Constable reviews the whole basis of conservation, especially in relation to problems of responsibility and general administration, and deals with the tasks of a curator as distinct from a conservator. An article on the Coronation Chair in Westminster Abbey proves that there have been two distinct decorative treatments, the first one consisting of paint and being in all probability Walter's original scheme. This was replaced at some undocumented date by a second one, richer and more elaborate, transforming the chair into a gilded throne. The radiographs also show the crude repairs of earlier times carried out with nails or screws. Prof. F. C. Thompson and Dr. A. K. Chatterjee write concerning the age-embrittlement of silver coins, and the issue closes with some useful reviews. Curators who also—and indeed should—deal with conservation will find much of interest and help in this new and worth-while publication.

University of London Appointments Board: Report for 1953

The forty-third annual report of the Appointments Board of the University of London, which covers the year ended December 31, 1953, notes specially, first a decrease in the number of registrations of men in the age-group 21–25 years (probably due to the increasing number who elect for National Service after taking their degree), and second, the doubling of the number of appointments secured by women graduates. Fewer teaching vacancies were notified to the Board; but there is no evidence to support the thesis that an increase in the number of graduates will alleviate the shortage of good teachers in scientific subjects. Although a number of good biologists on the Register are seeking a career in research or scientific work generally with no great prospects of suitable posts, they are unwilling to consider school teaching, although the vacancies are not unattractive. In previous years the greatest demand was for chemists; but during 1953 the main pressure was for engineers, chiefly those with mechanical and electrical training. There is a shortage of civil engineers for municipal work, and the Civil Service still attracts a substantial proportion of the best scientific workers and engineers. Of 617 men and women placed in full-time posts during the year, only four took science teaching posts in secondary schools, twenty taking university appointments, fourteen technical college appointments and twelve full-time tutorships. The Register at December 31, 1953, included 957 names compared with 1,042 on December 31, 1952; of these, 36 held an engineering degree, 50 general degrees in science, and 128 other degrees in science (biology, 39; chemistry, 31; mathematics, 33; and physics, 19).

United States National Museum: Annual Report for 1952–53

The annual report of the United States National Museum, under the direction of the Smithsonian Institution (pp. vii+98. Washington, D.C.: Government Printing Office, 1953), always provides stimulating and impressive reading, and that for 1953 is no exception. Starting with the recognized two-fold function of a museum to preserve objects for posterity and to enlarge the scope of human knowledge by a critical study of the collections, it continues with the outline of a scheme to modernize the exhibits. The Museum is really three museums in one: a natural history museum dealing with plants, animals and minerals; a museum of anthropology dealing with ancient and modern man and his works; and a museum of national history and technology. The present policy is to interpret this three-fold aspect in a broad, integrated panorama of life. The report then details some of the exhibition work which has already been accomplished towards this lofty goal. A most impressive part of the report is an account of the investigations and researches carried out by individual members of the staff—a clear indication that they have not allowed the factual minutiæ of day-by-day work to dull their imaginations. A total of more than a hundred and fifty papers were published during the year.

Lundy Field Society

The seventh annual report of the Lundy Field Society describes the year's working as one of consolidation. Much of the work on the non-avian fauna and the flora of Lundy was made up of contributions towards long-term surveys which are not yet complete enough for report. One paper, however, by M. T. Delany, describes his observations on the habitats of the bristle-tail, *Petrobius maritimus*. Within the limits of Lundy, the distributional range of this insect is wide. Providing rocks are available, whether they be slate or granite, capable of offering the appropriate cover, populations of *Petrobius* will survive. The factors, and their differential effects, responsible for the maintenance of the population balance of *Petrobius* in various localities have still to be determined. The other paper describes the observations of A. L. Galliford on the freshwater localities of Lundy; he now reports on the minute waterfleas and wheel animalcules. The report also includes a short summary on the domesticated and semi-domesticated stock which adorn the island.

British Weed Control Conference at Harrogate

The British Weed Control Conference will be held this year during November 2–4, at the Majestic Hotel, Harrogate, under the presidency of Sir James A. Scott Watson, chief scientific and agricultural adviser to the Ministry of Agriculture and Fisheries. The Conference is being organized by the British Weed Control Council, which is composed of representatives from the Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland, the Ministry of Agriculture for Northern Ireland, the Agricultural Research Council, the Colonial Office, the Association of British Insecticide Manufacturers, the British Agricultural Contractors Association, the National Association of Corn and Agricultural Merchants and the National Farmers Union. The formal papers will cover the present position of herbicides in British agriculture; cultivation and weed control; chemical weed control in the United States with special reference to horticulture; rotation of weed killers; spraying machinery; economics of commercial applications; legal aspects of spray damage; weed persistence and

dispersal; weed dispersal by machinery; the present position concerning the law; the Ministry approval scheme for herbicides; and woody weeds with particular reference to the British Colonies. In addition, reports will be presented by research workers from many sources on new herbicides, mixed herbicides and herbicides plus nutrient or crop-protection agents, total herbicides, mode of action of herbicides, experimental techniques, weed control in horticultural crops, grasses and legumes, and the winter spraying of cereals. Accommodation at the Majestic Hotel must be booked before October 4. A Conference registration fee of £2 10*s*. will be charged which will include a copy of the proceedings. All communications should be addressed to the Conference Treasurer, Mr. W. A. Williams, Association of British Insecticide Manufacturers, Cecil Chambers, 86 Strand, London, W.C.2.

Fourth World Forestry Congress, Dehra Dun

The Fourth World Forestry Congress will be held in Dehra Dun at the Indian Forestry Institute during December 11–22. The occasion will be of noteworthy interest in that this will be the first time that the Congress will have been held outside Europe, and although some aspects of the utilization of tropical timbers have been considered at previous Congresses, this will be the first one at which special emphasis will be laid on tropical forestry. The discussion on tropical sylviculture will also include the control of desert areas and problems arising from shifting cultivation in various parts of the tropics. In general, the theme of the Congress will be on the land economy and economic development of the country as a whole. Besides visits to forest areas in India, arrangements have also been made for the delegates to make tours in Pakistan. Further information regarding the Congress can be obtained from the Inspector-General of Forests, Ministry of Agriculture, New Delhi.

The Night Sky in September

Full moon occurs on Sept. 12d. 20h. 19m., U.T., and new moon on Sept. 27d. 00h. 50m. The following conjunctions with the moon take place: Sept. 1d. 15h., Venus 3° N.; Sept. 2d. 14h., Saturn 7° N.; Sept. 7d. 10h., Mars 3° S.; Sept. 21d. 16h., Jupiter 1° N.; Sept. 29d. 08h., Mercury 3° N.; Sept. 30d. 02h., Saturn 7° N.; Sept. 30d. 22h., Venus 1° S. In addition to these conjunctions with the moon, Jupiter is in conjunction with Pollux on Sept. 12d. 14h., Jupiter 6·7° S.; Venus is in conjunction with Saturn on Sept. 16d. 03h., Venus 6·1° S.; Mercury is in conjunction with Spica on Sept. 23d. 17h., Mercury 0·6° N. Mercury is too close to the sun throughout September to be seen. Venus is an evening star, setting at 19h. 50m., 19h. 10m. and 18h. 25m. at the beginning, middle and end of the month, respectively. The visible portion of the illuminated disk rapidly decreases from 0·513 to 0·341, but owing to the decrease in the planet's distance from the earth—from 67 to 46 millions of miles—the stellar magnitude increases from −4·0 to −4·2. Mars, an evening star, sets at 22h. 50m., 22h. 30m. and 22h. 15m. on September 1, 15 and 30, respectively: the planet's fairly large declination south—about 26°—renders it rather unfavourable for observation in the British Isles. Jupiter rises at 0h. 50m., 0h. 10m. and 23h. 25m. at the beginning, middle and end of the month, respectively; its easterly movement in the constellation Gemini is easily seen, and this movement will continue until the middle of November. Saturn sets at 20h. 40m., 19h. 45m. and 18h. 50m. on September 1, 15 and 30, respectively, but in the last case only about an hour after sunset. It is easily recognized in the constellation Virgo and is a little brighter than a first-magnitude star; its easterly movement takes it into the constellation Libra about the middle of the month. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Sept. 20d. 02h. 59·9m., 36*B* Gemi. (*R*); Sept. 24d. 04h. 29·9m., π Leon. (*R*); *R* refers to reappearance. Autumnal equinox occurs on Sept. 23d. 14h.

Announcements

The first Drummond Fellowship in nutrition has been awarded to Dr. Iain MacIntyre at the Postgraduate Medical School of London. The Drummond Fellowships are endowed from the proceeds of a recent appeal in memory of the late Sir Jack Drummond.

In order to deal with the numerous inquiries that are received for advice on the prevention of corrosion of ferrous metals, the British Iron and Steel Research Association has formed a Corrosion Advice Bureau, which will be at 140 Battersea Park Road, London, S.W.11. Dr. J. C. Hudson has been appointed head of the Bureau, Mr. E. E. White as secretary, and Dr. W. H. J. Vernon as consultant. The services of the Bureau will normally be free to members of the Association, and also available to others on a fee-paying basis.

The jubilee of the application by Sir Ambrose Fleming for the British patent for his thermionic valve will be celebrated by the Institution of Electrical Engineers on November 16, exactly fifty years after the event. The proceedings will be opened by the Lord President of the Council, the Marquess of Salisbury, and three lectures will be delivered, by Sir Edward Appleton, Prof. G. W. O. Howe and Dr. J. Thomson, respectively, dealing with valves from the earliest developments to the present day. There will also be an exhibition of historical apparatus.

The Seventeenth International Congress of Industrial Chemistry will be held in Brussels during September 11–19, this being the fifth time that the Congress has met in Belgium. The Congress will include twenty-nine sections grouped under the following ten main headings: general problems of the chemical industry; fuels; nuclear science; metallurgy; industrial inorganic chemistry; cements, building materials, glassware, ceramics and enamels; industrial organic chemistry; foodstuffs and agricultural industries; Colonial problems; and organization (industrial, commercial and professional). Further information can be obtained either from the Secrétariat du Comité d'Organisation, XXVIIème Congrès International de Chimie Industrielle, 32 Rue Joseph II, Brussels, or from the Commission permanente d'Organisation des Congrès de Chimie Industrielle, 28 Rue Saint Dominique, Paris 7e.

W. Watson and Sons, Ltd. (313 High Holborn, London, W.C.1), makers of microscopes, optical and scientific instruments, are holding an exhibition on "The Microscope in Industry and Research", in Milton Hall, Deansgate, Manchester, during September 20–25 (10.30 a.m.–7.30 p.m.; except September 25, closing at 2 p.m.). Eighteen firms or other organizations are supplying exhibits illustrating the microscope in connexion with various processes.

DEVELOPMENT AND WELFARE IN THE BRITISH COLONIES

REPORT FOR 1953–54

THE schemes detailed in the latest return made under the Colonial Development and Welfare Acts, covering the period April 1, 1953–March 31, 1954*, bring the total commitments for development and welfare schemes under the Acts to £110,879,335, of which £14,729,660 was for the year in question, and for research schemes to £12,401,606, of which £716,818 was for the year ended March 31, 1954. Of this last-named sum, £249,596 was for agriculture, £205,312 for medicine, £83,226 for social science, £96,923 for insecticides, £22,100 for tsetse and trypanosomiasis, £32,295 for products research, £7,137 for fisheries and £7,059 for economic research. There were no grants for research fellowships.

Of the actual research schemes, much the largest were £123,743 for the establishment of the West African Council for Medical Research, £110,000 for the continuation of research at the East African Veterinary Research Organization, a supplementary £66,984 for the maintenance of the West Indian Institute of Social and Economic Research and £50,000 for the control of malaria in the hyper-endemic area at Taveta-Pare, East Africa. A supplementary £31,330 was provided for the continuation of sugar technology research at the Imperial College of Tropical Agriculture, Trinidad, while the West Indies also received £23,371 for research into the 'unknown' disease of coconuts and Panama disease of bananas, and £14,300 for banana breeding research (both in Jamaica) and a supplementary £2,444 for research into the control of leaf-scald disease of sugar-cane in British Guiana. East Africa received supplementary grants of £18,750 for the preparation of the "Flora of Tropical East Africa" at the Royal Botanic Gardens, Kew, £16,000 for the establishment of a malarial unit and £8,500 for the establishment of a team in Tanganyika for insecticides research on the control of crop pests.

In West Africa £14,780 was provided for the establishment of a fungicide research unit, £12,250 for the maintenance of the West African Institute for Trypanosomiasis Research, £12,290 for the expansion of the Veterinary Research Laboratory, Vom, Nigeria, and £9,850 for a pilot scheme for tsetse reclamation. £16,022 was provided for an investigation into the control of filariasis in Fiji by insecticidal methods, and £6,975 for the establishment of the Fisheries Research Unit at the University of Hong Kong. In south-east Asia the Federation of Malaya received £14,915 for research on virus and other diseases transmissible from animals to men and £9,334 for the establishment of a Timber Research Station, and North Borneo £9,784 for an investigation of the diseases of the manila hemp plant. A general grant of £13,525 was for the establishment of a pool of Colonial soil surveyors.

Grants of particular scientific interest for development and welfare schemes include the following: £182,101 for the Desert Locust Control campaign in East Africa; £37,000 for the establishment of the agricultural and veterinary training centre at Lilongwe, Nyasaland; £22,300 for the development of medical and health services in Gambia; £474,600 for land planning and soil conservation in the Northern Territories of the Gold Coast; £162,030 for the control of leprosy in Nigeria, for which £181,335 is also provided for a scheme in the Development Plan towards which a supplementary £2,583,551 was granted. Out of that sum, supplementary schemes for agriculture received £273,417, for technical education £347,113, and for medical and health £386,679. £100,000 was provided for tsetse control in the northern region of Nigeria, £68,039 for the geological survey of Sierra Leone, while among other grants the University College of the West Indies and its associated teaching hospital received £120,000 for the main building programme; the Nigerian College of Arts, Science and Technology, Ibadan, £124,410 for the construction of student accommodation; the University College of the Gold Coast, £400,000 for the construction of a hall of residence; University College, Ibadan, £51,600 for the development of the permanent site; and Makerere College, £180,000 for the construction of a men's hall of residence, senior staff housing and science laboratory.

* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies with the Concurrence of the Treasury, in the Period from 1 April, 1953, to 31 March, 1954. (Colonial No. 181.) Pp. 26. (London: H.M. Stationery Office, 1954.) 1s. 3d. net.

PROFESSIONAL, TECHNICAL AND SCIENTIFIC CIVIL SERVANTS

IN evidence submitted to the Royal Commission on the Civil Service, the Institution of Professional Civil Servants claims that the status and standing of professional, technical and scientific Civil servants in relation to the remainder of the Civil Service should more accurately reflect the relations existing between the administrator and the professional man outside the Civil Service and the importance of the professional man in the life of the country as a whole; they should also be such as to encourage young people to take up professional, scientific and technical careers. At present the heads of the various sections of the professional Civil Service are in an unsatisfactory position with respect to each other and especially to the administrative class; the highest professional officer is always a grade lower than his administrative colleague, and this relation, applying right down to the lowest technical grades, is a factor in diminishing the attractiveness of such careers.

After referring to Lord Cherwell's statement for the Government in 1943, and the representations made in the Barlow Report and by the Parliamentary and Scientific Committee, the Institution urges that the Commission has the opportunity to place science

on an equality with administration and that this would constitute a major advance. It suggests that there is complete justification for the claim that the post of deputy chief scientific officer should rank with that of under-secretary in the administrative class; that of senior principal scientific officer should rank with that of assistant secretary, while the senior scientific officer grade should be abolished or combined with that of principal scientific officer to rank with that of principal in the administrative class. The scientific officer grade should rank with that of assistant principal, and a considerable increase in the number of posts in grades above that of principal scientific officer is necessary to make the career open to the scientist sufficiently attractive compared with that open to the administrator.

As regards the works group of professional classes, whose position was reviewed by the Gardiner Committee in 1951, the Institution submits that a wholesale change is necessary to put such professional officers on a basis that reasonably recognizes the degree of responsibility they carry compared with that of the administrative class. It is suggested that the main grade should be equated with the administrative principal, the senior grade with the assistant secretary and the superintending grade with the under-secretary in the administrative class. As regards the experimental officer class, the Institution submits that a broad comparison should be made between the assistant experimental officer and the executive officer, the experimental officer and the higher executive officer, the senior experimental officer and the senior executive officer and between the chief experimental officer and the chief executive officer, with salary scales favouring the experimental officer class in view of the higher standard of qualification, the inferior promotion prospects and the increased responsibilities. For the assistant (scientific) class, the Institution submits that the assistant (scientific) and the senior assistant (scientific) grades should be placed on salary scales sufficiently higher than those of clerical officer and higher clerical officer to be attractive in competition with the careers and salaries available to officers in those grades. It is also submitted that to provide a proper career for technical officers it is imperative to increase the scales of these classes to a basis of parity with the executive class. Other proposals relate to the admission to the appropriate professional scales of those who have obtained professional qualifications after entry to the Civil Service and for the simplification and reduction of the number of salary scales.

BRITISH WELDING RESEARCH ASSOCIATION

THE ninth annual general meeting of the British Welding Research Association was held on July 14 at the Association's Engineering Research Station at Abington, near Cambridge, under the chairmanship of the president, Sir William J. Larke. At the subsequent luncheon, a toast to the Association was proposed by Dr. O. Wansbrough Jones, chief scientist, Ministry of Supply, and acknowledged by Sir Charles S. Lillicrap, chairman of the Council. In his speech, Sir Charles made reference to the annual income, which had reached £113,000 (being an increase of £20,000 over that for the previous year), and also to the new terms of the grant from the Department of Scientific and Industrial Research, which had again been agreed for the next two years at the level of £100 for each £100 of membership subscription. Nevertheless, it was pointed out that, in order to qualify for this grant after the end of the period, it would be necessary for the annual subscription income to be raised by £10,000 to £50,000. He was sure that this would be possible, if the goodwill of members was secured. Mention was also made of the Association's intention to move the metallurgical researches from London to Abington in the near future. For this purpose a provision of £40,000 has been made for new laboratories, and a housing association has been formed.

During the day an exhibition was staged of metallurgical work in progress, and the engineering laboratories were open to view. The metallurgical work is to be the subject of a separate open day in the autumn, and the examples illustrated were confined to the micro-analysis of hydrogen in metals and weld deposits, and the development of a suitable cracking test for light alloy welds with various parent materials and filler alloys. Associated work has shown the important influence of silicon dilution of the filler alloy by the parent plate, as a cause of cracking in welds made in the heat-treatable aluminium alloy H.10.

In the fatigue laboratory tests were shown in progress on butt welds in heavy sections of steel plate and tube. Various welding methods are being investigated, together with the effect of deliberately introduced faults. An interesting effect of one such fault—lack of penetration—which introduces the equivalent of a sharp notch, is that although the joint fatigue strength is much impaired, the relative scatter of results is reduced to negligible proportions. In another test, conducted co-operatively with the Department of Metallurgy, University of Cambridge, large steel specimens which have been fatigue-tested to destruction have been sub-divided so as to avoid the main fracture faces, for further fatigue tests on a smaller scale. Such specimens have shown no diminution of fatigue life as compared with otherwise identical control specimens taken from the unstressed ends of the larger specimens.

Although the work of Prof. J. F. Baker and others at the Department of Engineering, University of Cambridge, on the plastic design of welded steel frames has reached fruition, in that buildings so designed are giving satisfactory service (including the fatigue laboratory already mentioned), full-scale investigations continue to take place. On an outdoor site a full-scale portal frame was shown which had been loaded to destruction. This particular test convincingly demonstrated that the additional stiffening effect of fully encastered feet could be obtained with simple and economical concrete foundations.

In past years the use of welding has made possible the construction of pressure vessels and pipelines to suit exacting operating conditions in the steam, oil and chemical industries. In such cases the technicalities of welding and design are inseparable, and much attention is paid by the Association to stress analysis, particularly with regard to the reinforcement of openings in pressure vessels, and the behaviour of pipeline components such as bends and branches where expansion movements have to be sustained. Tests on a number of such components were on view. Experiments on the reinforcement of openings were represented by a steam drum for

stress analysis containing six nozzle openings, each with a different type of reinforcement; a pulsating pressure test on small vessels of about 0·3 m.³ capacity to determine the efficiency of different types of nozzle weld preparation; and a pressure cell in which a portion of plate 3·0 m. × 2·4 m. containing a manhole opening 60 cm. diameter had been tested under hydrostatic pressure, simulating the loading which would be sustained when present in an oil-storage tank 40 m. in diameter. This test could not be made on a smaller scale since it was necessary to determine the reserve of ductility as well as the stress distribution in the plate containing the manhole.

During the year the resistance welding laboratory has been almost completely re-equipped in order to meet new programmes of work. The main acquisition, through a Mutual Security Aid grant from the United States, has been a Sciaky three-phase spot-welding machine of large capacity for use mainly with light alloys. As a result of previously conducted fundamental work on heat flow, it has been proved possible to calculate optimum and electrical and thermal cycles for spot welds in hardenable steels. Electronic timing equipment has now been installed, so that the work may proceed with examination of complex thermal cycles by means of which individual spot welds may be heat-treated immediately after they are made.

Experience in the welding industry has already shown that the ultrasonic probe is a powerful tool for non-destructive testing, and one which is often more discriminating than radiography. The two methods may best be described as complementary. Nevertheless, the technique for ultrasonic testing is not easily acquired or taught, and the work of the Association is directed towards the choice of the best methods for examining particular designs of welded joints, while using commercially available equipment. Illustrations were on view of the success which has been achieved with quite complex welded joints, including fillets.

In spite of the research effort which has been expended, brittle fracture still takes a certain toll of steel structures fabricated both by welding and riveting. The use of steels with improved notch toughness can undoubtedly reduce the hazard; but the contribution to safety of better methods of fabrication cannot be ignored. In this direction the Association is investigating problems of the mechanics of such fractures. A new galvanometer was shown by means of which it has been possible to measure the surface energy of a propagating fracture by detecting the plastic-flow heat which is evolved. In this string instrument, which is used with thermocouples, extreme sensitivity has been achieved without high electromagnetic damping by using a very small controlling field, and suspending the strings in a deep catenary to secure the minimum tension. The instrument is being used for studying the influence of stored elastic energy from residual welding stresses on the propagation of fractures in notch-brittle steels. For this purpose, since it is impossible to secure complete residual stress systems other than in wide plates, a 600-ton tensile testing rig has recently been constructed and was on view. This rig was designed by Association investigators and donated by a member firm. Calibration of each of the four hydraulic-loading capsules in the rig was carried out in a Baldwin 180-ton universal testing machine which has recently been acquired through Mutual Security Aid funds.

PHYSICAL AND CHEMICAL ASPECTS OF BASIC MECHANISMS IN RADIOBIOLOGY

A VERBATIM report has been prepared on an informal conference of physicists, chemists and biologists held during May 7–9, 1953, at Highland Park, Illinois, to discuss the interaction of radiation and biological systems in its basic aspects*. The foreword emphasizes that "There was no attempt to make the discussions comprehensive; but rather topics of current interest were discussed and analysed". There are five main sections. The first two, dealing with the energy transfer from radiation to matter, were introduced by Robert L. Platzman, of Purdue University. The mechanisms of energy degradation and chemical change and effects of secondary electrons were considered in Section 3, which was introduced by John L. Magee, of the University of Notre Dame. Discussion of the effects of electronic excitation in Section 4 was introduced by Henry Linschitz, of Syracuse University. The final section, which is headed as "Summary: Importance of Radiation Chemical Effects in Radiobiology", was introduced by Martin D. Kamen, of Washington University Medical School, and is, in some ways, the most interesting part of the whole proceedings. The list of references to the individual sections are collected at the end of the papers and deal mainly with work published during and since 1950.

The presentation in the form of a verbatim record, which appears to be very well edited, is a useful way of treating a subject in which there is so much that is problematical. The book deals with those problems which everyone working in these various fields discusses repeatedly, usually without definite conclusions. Probably no single reader will be able to understand the whole of the discussion. The uncertainty of knowledge of the basic physico-chemical mechanisms involved and lack of the necessary experimental evidence is emphasized repeatedly, and often interesting suggestions for further experimental work arise in the course of the discussion.

The basic lack of knowledge is emphasized in connexion with the value of W, the mean energy expended per ion pair. It is useful to quote from p. 5: "All this has a strong moral in radiobiology, and it is one which even the physicist has often taken too lightly . . . namely, that one really knows virtually nothing about the value of W to apply for tissue. Even with a wholesome amount of grains of salt, it seems highly doubtful that this quantity has any present significance in radiobiology". It is interesting that recent experimental evidence tends to confirm Fano's approximate theory of W. Mention is made (p. 2) of the work of Lindhard and Scharff on the theory of stopping-power. The uncertainty of the position concerning the experimental evidence for the stopping-power of α-particles by liquid water is mentioned. Attention is directed to the interesting experiments of Ageno (p. 14) and the whole problem of energy transfer. A practical point of interest is made on p. 19 where Fano points out that, if a 1-MV. photon strikes a water surface, the probability of its emerging

* Physical and Chemical Aspects of Basic Mechanisms in Radiobiology: Proceedings of an Informal Conference held at Highland Park, Illinois, May 7–9, 1953. (Publication 305 of the National Academy of Sciences: Division of Physical Sciences of the National Research Council.) Edited by John L. Magee, Martin D. Kamen and Robert L. Platzman. Pp. vii+145. (Washington, D.C.: National Research Council, 1953.) 1 dollar.

back out again is of the order of one-third. On p. 68 Platzman refers to his earlier statements at the Oberlin conference and, in particular, that the whole subject of ionization is very vague in liquid water. On p. 67 there is an interesting discussion on stable, long-lived excited states of water, and the problem of the linear HOH molecule in a triplet state with low energy is discussed.

At the end of the section on electronic excitation, the important problem of the nature of radiomimetic action is discussed; but no real conclusion is reached as to its mechanism. Attention is directed to the work of A. Kellner (*J. Bacteriol.*, 65, 252; 1953) on the growth, respiration and nucleic acid synthesis in ultra-violet irradiated and in photo-reactivated *E. coli*, the deoxyribonucleic acid synthesis being stopped immediately after irradiation and restarted after reactivation. The problem of triplet states with the possibility of long-lived states in complex molecules is discussed again on p. 115. Of particular interest is the discussion on the effects of radiation on the unfolding of proteins and the mechanism of building of adaptive enzymes. The important problem of oxygen effects is not discussed explicitly, and I would like to suggest that this is a problem which might engage the attention of similar conferences.

The book as a whole is very stimulating and should interest physical chemists and physicists, in the important experimental and theoretical problems arising in connexion with the effects of ionizing radiations on the complex systems in aqueous solution which must be studied as a foundation for the understanding of the biological actions of radiations. A conference such as this is obviously of the greatest value to the participants, and one must be grateful that a report such as this is now available.

J. S. Mitchell

CURRENT TRENDS OF GENETICAL RESEARCH IN HUNGARY

By ANNE McLAREN and DONALD MICHIE
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We recently had an opportunity of visiting a number of laboratories in Hungary in which genetical research is in progress.

Our first visit was to Prof. Györffy, who directs the Hungarian Academy of Sciences' Institute of Agrobiology in Budapest. A major activity of the Institute at present is the investigation of possible genetic effects produced in young plants by vegetative contact with partners of contrasting genotype. For example, it has been claimed by Michurin (see Waddington[1]) that interspecific crosses which are normally difficult or impossible to obtain can be facilitated by previous grafting between the intended sexual partners. Working with tobacco species, Györffy has found that this method, which has been termed 'vegetative approximation', is strikingly effective in crosses of *Nicotiana glauca* with *N. tabacum* and *N. rustica*, but without effect in crosses between *N. tabacum* and *N. alata*.

Györffy has also used *N. tabacum* for investigating claims of 'vegetative hybridization' made by French and Russian workers (for example, Daniel[2], Glushchenko[3]). It is suggested that, in the seed generation obtained by selfing a grafted plant, variant forms sometimes appear with characters apparently derived from the stock on to which the parent was grafted. In Györffy's experiment spines appeared on the capsules of tobacco plants which had been grafted on to *Datura*. A weaker expression of the modification appeared in the seed generation, but not in subsequent generations. Györffy intends to publish in due course an account of all the recent tobacco work of this Institute.

A large-scale experimental attempt to obtain 'vegetative hybridization' by intervarietal grafting in tomatoes was also undertaken; but no visible modifications appeared either in the grafted plants or in their descendants. Biochemical analyses are now in progress to determine whether the results are also negative in respect of 'physiological' characters. Györffy has also been encouraged by Felföldy's recent positive results (see below) to embark on a new attempt with starting-varieties, which he is now preparing, differing in as many characters as possible.

In addition, a laboratory for the genetics of micro-organisms has recently been set up in the Institute. Pontecorvo's work on heterokaryosis is being followed up in *Penicillium*; a method for prolonging the haploid phase in yeasts is being used for investigations on directed mutagenesis; and studies on the transfer of heritable properties by killed cells in *Rhizobium* are being made. This work is in part designed to throw light on 'vegetative hybridization', in the belief that heritable effects of the host upon grafted plants may be analogous to the phenomena of 'transduction' (see Stocker, Zinder and Lederberg[4]) or 'transformation' (see Avery, McLeod and McCarty[5]) in bacteria.

In search of further information on tomato-grafting experiments we visited Dr. Felföldy in the recently founded Botanical Department of the Biological Research Institute at Tihany on Lake Balaton.

The results of his experiment, up to and including the seed generation, have been published in English[6]. The present remarks include some additional material.

Of the six possible scion-stock combinations obtainable with the three varieties Pruniforme, Oxheart and

Table 1. Classification for Mendelian Characters of the Seed Generation obtained by Selfing Grafted and Control Plants. The convention *A/a* denotes intra-plant variation in the character

Parental plants	Phenotypes in the seed germination	No. of fully classified plants	Subsequent behaviour in five generations of selfing
Oxheart (control)	*R y o n f*	40	Bred true
Oxheart grafted on Golden Apple	*R y o n f*	18	Bred true
	R y O N f	12	Continued to segregate
	R Y O/o N F/f	1	Continued to segregate
	R Y O N F/f	5	Continued to segregate
	Perished	4	
	Total	40	
Golden Apple (control)	*r Y O N F*	40	Bred true
Golden Apple grafted on Oxheart	*r Y O N F*	32	Bred true
	r Y O N f	2	Reverted to *r Y O N F* in F_3
	R/r Y O N f	6	Bred true
	Total	40	

R = red, *r* = yellow (flesh). *Y* = yellow, *y* = colourless (skin). *O* = short, *o* = long (fruit shape). *N* = normal, *n* = nipple-tipped (fruit-shape). *F* = normal, *f* = fasciated (many-chambered in cross-section)

Golden Apple, only the two reciprocal combinations of Oxheart with Golden Apple showed any striking effects of the treatment. These two varieties differ in five major Mendelian characters; but the modifications were confined in the graft generation to an increase of sugar-content and luxuriance in the grafted plants as compared with self-grafted controls. But when the grafted plants were selfed, variant forms appeared in the first seed generation showing characters apparently derived from the stock. Data are given in Table 1 (notation based on Boswell[7]).

In addition, changes in foliage type and in several physiological characters appeared in the seed generation. Dr. Felföldy has concluded that the phenomenon of 'vegetative hybridization' is conditional upon the particular pair of varieties chosen to act as stock and scion, and that the optimal circumstance is that the two varieties should differ in as many physiological properties as possible. He suggests that this may throw light on the negative results obtained by some other workers (see, for example, Sachs[8]). But Dr. A. J. Bateman informs us that at the John Innes Horticultural Institution he obtained negative results from a similar experiment starting with seed supplied by Dr. Felföldy. Next year Dr. Felföldy himself plans to repeat the experiment and to make a concomitant study of sexual crosses between the same varieties.

In the same Institute we spoke with Dr. Fabian, who is working on mammalian genetics in collaboration with Drs. Csik and Stohl. Studies (in the press) have been made by Fabian on the inheritance of morphological characters in reciprocal crosses between *Mus musculus domesticus* and *Mus musculus spicilegus*. Significant evidence of maternal effects was found for skull dimensions, depth of nasal groove, and the ratio of tail to body-length. Heterotic effects were noted in skull-length, body-length and total weight.

Fabian has also been crossing wild rabbits with the 'Belgian' domesticated variety, and has observed a significant maternal effect on skull size in reciprocal crosses. With the object of seeking parallels between phylogenetic and ontogenetic adaptations, studies are now proceeding on the effects of conditions of rearing upon biochemical characters for which the two parent populations differ.

We were able to examine other work on animal breeding and genetics in the Institute of Small Animal Husbandry at Gödöllö. Here most of the genetical projects are still in a preliminary stage.

Dr. Mészáros, from the Institute of Animal Husbandry in Budapest, is injecting sperm from various poultry breeds, and also duck and turkey sperm, into the albumen of fertile eggs of White Leghorn hens on the second day of incubation. It is believed that specific nucleoproteins carried in by the additional sperm may have detectable and specific effects on the course of embryonic development.

An attempt is being made using Rhode Island Reds and White Leghorns to follow up Bratanov's[9] report that the offspring of White Leghorn hens which had been transfused with blood from turkeys were larger and faster-growing than control chicks, and also that some showed pigmentary changes.

Dr. Mészáros also told us that he is using blood transfusion between sheep and goats as a method of 'vegetative approximation', having visited Bratanov's laboratory in Bulgaria and seen live sheep–goat hybrids said to have been obtained by this procedure (for previous attempts, all unsuccessful, to obtain viable hybrids, see Gray[10]). In the same Department, Mr. Piko is using blood transfusion in studies of duck–goose and hen–turkey hybridization.

Dr. Mészáros is also directing all work conducted on artificial insemination in Hungary, where the number of cows artificially inseminated is expected to rise this year from 30,000 to 50,000, and of mares from 65,000 to more than 70,000. In connexion with this work he has made the observation that the fertilization-rate in cattle is increased some 15 per cent by using a mixture of sperm from two different bulls of the same breed. He has evidence that the effect is due to an increased motility of the sperm when in contact with seminal fluid from a genetically different donor. The same effect has been observed in horses and sheep.

Hungarian genetical workers whom we did not visit include Prof. Horn, of Debrecen University, who is making endocrinological studies of the sterility of the economically valuable Peking × Muscovy duck hybrid, and Academician Sedlmayr, who claims to have transferred the heritable character 'anthocyanin-less' by intervarietal grafting in sugar-beet.

All the genetical workers whom we met shared the sense of regret which is widely felt in Britain at the recent lack of communication and understanding between the split halves of the international genetical fraternity. It is in the hope of contributing something towards the re-establishment of this communication that we have prepared this brief and incomplete survey.

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[3] Glushchenko, I. E., "Vegetativnaya Hibridizatziya Rastenii" (Moscow, 1948).
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[5] Avery, O. T., McLeod, C. M., and McCarty M., *J. Exp. Med.*, **79**, 137 (1944).
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[9] Bratanov, K., *Izv. Acad. Nauk SSSR* (Ser. Biol.), No. 1, 53 (1954).
[10] Gray, A. P., "Mammalian Hybrids" (Commonwealth Agricultural Bureaux, Farnham Royal, 1954).

BRITAIN'S FORESTS

THE Forestry Commission is producing a series of booklets on "Britain's Forests", two of which deal respectively with the forests at Glentress and Drumtochty*.

Glentress Forest, close to the old Border town of Peebles, was one of the first planting projects in Scotland by the Forestry Commission through the acquisition from the Haystoun Estate of what is now the oldest portion of Glentress Forest, in co-operation with the Department of Agriculture, which was then setting up a land settlement scheme for ex-Service men. Work began there in 1920, and Glentress now includes more than two thousand acres of the hill slopes. The old woodlands and upper hill slopes amounting to 873 acres in all were taken over by the Forestry Commission. Most of these lands lie in the Eschiels of Glentress valley at the eastern end of the forest extending down to the banks of the Tweed; but the braes of Ven Law just behind the town of Peebles were also included. At that date about three hundred acres carried woodland, mostly European larch planted during 1903–5, while the rest was either

* Britain's Forests. Glentress; pp. 18; 1*s* net. Drumtochty; pp. 20; 1*s*. 3*d*. net. (London: H.M.S.O., 1953.)

former woodland that had been cleared of trees or hill ground suitable for afforestation.

In 1932 the forest was extended by the addition of about a thousand acres of ground on the north-west in the Soonhope or Shielgreen Glen. The 1903 larch plantations around Eschiels had to be felled during the Second World War. The Forestry Commission has been planting mainly Scots and Corsican pines, Norway and Sitka spruces, Douglas fir and both European and Japanese larches. Thinnings have been already commenced in the older plantations, necessitating the construction of additional roads, so there is plenty of work demanding labour in the area. A forester's training school was established there in 1945, but was moved in 1953 to Faskally, near Pitlochry. The pamphlet is well illustrated.

Drumtochty Forest is another of the Forestry Commission's forests thus described. The traveller who passes through the Howe o' the Mearns, either by road or rail, comes within a few miles of Drumtochty, and if he looks to the west he will see the new forest clothing the slopes of Strathfinella Hill. Moreover, the Glens o' Drumtochty, in the heart of the forest, is on a well-known beauty spot, visited every summer by thousands of tourists; and, indeed, the whole of Kincardineshire, though small, is rich in contrasts by virture of the high heather-clad Grampians which come down almost to the sea at Stonehaven. The forest is situated on the south face of the Grampians, extending now to 3,340 acres, with 2,400 acres of thriving woodlands established on land too poor for agriculture. It looks out over the Howe o' the Mearns, a fertile hollow famed for its rich harvests of grain and potatoes and its fat cattle. Beyond the Howe to the east stands a low ridge of sheltering hills bordering the rugged coast of the North Sea with its little fishing villages hidden away below the cliffs.

The main routes from the south, which come up the great valley of Strathmore from Perth, traverse the Howe on the way to Stonehaven and Aberdeen. Most of the planting was done between 1927 and 1937. Larches were planted, of which the Japanese and the hybrid have done best on slopes up to a thousand feet. For the moister ground the Norway spruce and Sitka spruce are used, the former where spring frosts are likely to be severe. At lower levels in the glens *Abies grandis* and *A. nobilis*, Douglas fir, western red cedar and the western hemlock have been used; also the Serbian spruce *Picea smorika*. Planting is now giving place to the harvesting of the thinnings from the older plantations, and a first return is being obtained for the outlay. This pamphlet is also well illustrated.

COCOA FERMENTATION

By R. V. WADSWORTH and G. R. HOWAT
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Proposed Method for fermenting Small Quantities

AN attempt has been made to solve the problem of the fermentation of small quantities of cocoa beans. A solution to the problem is particularly urgent at the present time when botanists have made available a large number of new varieties of cocoa. What has been lacking is a satisfactory method of fermenting beans from only one or two pods of each variety, to enable an early and accurate assessment to be made of their quality and acceptability to chocolate manufacturers.

For our experiments, pods of West African Amelonado cocoa were flown from the Gold Coast by commercial airline. Usually they arrived at Bournville about 24–30 hr. after leaving Accra. On arrival the pods were swabbed with a solution of a quaternary ammonium compound to remove surface moulds and other organisms. Tests for viability were made on a few beans by staining technique[1] and by germination tests. It was found that no chocolate flavour could be developed from dead beans, and the time of death was an important factor.

Two methods of fermentation were developed. In the first method an apparatus similar to that described by De Witt[2] was used. The pods were opened under aseptic conditions and the beans were sprayed with a mixed culture of a yeast, *Hansenula anomala*, and an acetic acid producing organism, *Bacillus orleanense*.

Knapp (ref. 3, pp. 17, 30) states that both these organisms are found frequently in commercial fermentations. The inoculum was about 20 million organisms suspended in 10 ml. of Ringer's solution. In accordance with the practice adopted in good commercial fermentations, the beans were well stirred every second day.

Fig. 1 shows the fermentation curve aimed at using this method. It will be noted that during the first 3½ days the temperature should not exceed 38° C. During the last three days the temperature should be about 50–51° C.

At the end of the fermentation period, the beans were dried in a cabinet maintained at a high humidity to simulate West African conditions. Heat was supplied by a 100-W. electric light bulb. The temperature was not thermostatically controlled and it varied between 45° and 50° C. Under these conditions, drying to a moisture content of about 6 per cent took five or six days.

Beans prepared by this method and using the temperature limits shown in Fig. 1 were generally brown in colour and had cotyledons with an open texture. A few beans showing some purple colour in the cotyledons were found in most of the experiments. It was found that the beans from these fermentations, after roasting and shelling, could be made into chocolate with a good chocolate flavour.

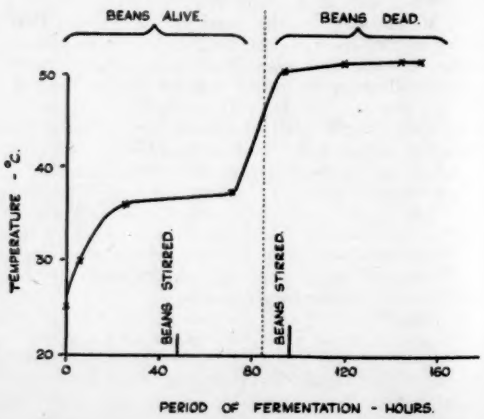

Fig. 1

The second method involved the use of 'aseptic fermentations'. In these, the beans were maintained at any desired temperature in a water-bath or incubator. The pulp was not removed; but the beans were sprayed with a very dilute solution of a quaternary ammonium compound to prevent the growth of organisms in the pulp during 'fermentation'. This method is capable of general application, and it is independent of the chance presence of desirable (or undesirable) micro-organisms in the atmosphere or the use of pure cultures. Suitably modified, we have been able to ferment successfully single beans by this method. In our later experiments the aseptic method was used exclusively, and we consider it less liable to variation than the traditional method.

Details of the aseptic method are as follows. The beans are removed from the pods under aseptic conditions and placed in sterile glass vessels. If the beans from two or three pods are being fermented, tall 600-ml. beakers are suitable. The beans are then sprayed with a solution containing 300 p.p.m. of a quaternary ammonium compound. The beakers are fitted with false bottoms prepared by placing inverted watch glasses on a framework of glass rod. Any liquid produced during 'fermentation' consequently drains away from the beans. The top of each beaker is covered with several thicknesses of aluminium foil and this is kept in place with a tight rubber band.

The beakers are placed in a water-bath or incubator kept at a temperature of 35° C. and allowed to remain there for a period of 84 hr. (3½ days). During this period a considerable volume of carbon dioxide gas is produced and it is essential that this should be removed. It can be done in one of two ways. A quantity of potassium hydroxide solution can be placed under the watch glass at the bottom of the beaker, or the beans can be thoroughly stirred after 24, 48, and 72 hr., and at 84 hr. The first method is probably the better; but it will be remembered that in no circumstances should the potassium hydroxide solution come into contact with the beans.

The beaker containing the beans is then transferred to a water-bath or incubator at 50° C. and kept at this temperature for a period of 72 hr. (3 days). Although production of carbon dioxide at 50° C. is limited to the first few hours (until the death of the bean), it is desirable that even this small quantity of gas be removed. This can be done either by stirring after 24 hr. at 50° C. or by the use of potassium hydroxide solution.

At the end of the period the 'fermented' beans are plump, and when cut exude a small quantity of dark brown liquid. The cotyledons are open and can readily be separated from each other. They are a pale watery purple colour, possibly with a background of brown.

The beans are now transferred to a drying cabinet and dried under the same conditions as those fermented naturally. When dry, the beans will be found to have a loose shell and, on cutting, the cotyledons will be found to be dark brown in colour and to have an open texture. After roasting and shelling they can be made into chocolate which has a good chocolate flavour.

Factors Involved in Fermentation

Recent experiments on the fermentation of small quantities of West African Amelonado cocoa in these laboratories have directed attention to several aspects of the changes involved in fermentation which do not appear to have been noted previously. At least three factors play a part in the development of chocolate flavour.

The first is the germination processes in the bean during the first part of fermentation. This seems to have been accorded no importance in previous work. Indeed, Knapp (ref. 3, p. 134) states that "until the bean is killed no change takes place in the interior, so that it is desirable to raise the temperature rapidly to accomplish this". Our experiments have shown that this view is incorrect. Beans which have been killed by cold—24 hr. in a refrigerator at 1–1·5° C.—and then fermented using pure cultures of organisms, or prepared by the aseptic method, do not produce anything resembling a chocolate flavour. Also, when beans are maintained at a temperature of 50° C. for several days without a prior period at a germinating temperature, no chocolate flavour is developed.

The second factor is that the beans must be maintained at a temperature of about 50° C. for several days after the initial germination period. If this is omitted and the beans maintained at around 35° C. for five days, they give either a mild flavour which is reminiscent of caramels, or have a slight liquorice character when made into chocolate. In addition, the colour of such beans after drying is not brown, it is purple. At higher temperatures the degree of purple remaining in the finished beans is less; but it is our experience that even when a temperature of 45–46° C. is maintained instead of 50° C., some purple background is present and there is bitterness in the chocolate produced. It should be noted that the temperatures used in our aseptic fermentations approximate roughly to those observed in good commercial fermentations. The nature of the changes produced during this period has not been studied by us in detail. They are, however, undoubtedly associated mainly with changes in the polyphenols, as has been noted by Forsyth[4].

The third factor is the removal of carbon dioxide from the air around the fermenting beans. It is well known, of course, that carbon dioxide is produced in fermenting cocoa. There appears, however, to be no published record that large quantities of carbon dioxide are produced by the bean itself—as distinct from fermentation of the pulp—during the early stages of fermentation.

Our experiments have shown that when fermented under aseptic conditions, the carbon dioxide content of the atmosphere around the cocoa beans may rise as high as 90 per cent during the first three days. In fermenting single-bean samples, we have found that a single cocoa bean (dry weight 1·2 gm.) produces up to 10 ml. carbon dioxide at N.T.P. during the early stages of fermentation. There is apparently no liberation of carbon dioxide after the bean dies.

In certain experiments an atmosphere of carbon dioxide was maintained around the beans during the period they were held at 50° C. or during drying. In each case it was found that the chocolate prepared from such beans was unpleasant and had no chocolate flavour.

It is interesting to note that in good commercial fermentations the practice is to turn the cocoa or to mix it every second day. This will have the desired result, if properly done, of removing the carbon dioxide.

Two other points have interested us. One is that during fermentation very little change takes place in

the *p*H of the cotyledons. In our fermentations, using pure cultures of organisms, we found that the *p*H of the pulp fell from about 4 to 2·5. There was no similar fall in the *p*H of the cotyledons; here a slight reduction, from 5·5 to 5, was all that was noted.

This point is of particular interest in that it has been frequently suggested that the flavour of fermented beans is affected by the character of the fermentation which it has undergone, and that the esters formed during fermentation may permeate the testa and pass into the cotyledons. In the light of our findings, this seems unlikely.

The other point which interested us was the gap in temperature that exists between the thermal death-point of the organisms which occur in commercial fermentations and the maximum temperature recorded in a fermenting heap. The thermal death-point of most organisms occurring in commercial fermentations is 43–44° C. as observed by Rombouts[5]. The maximum temperature recorded in good fermentation practice is, however, usually 50–51° C. It appears possible that the heat produced by the enzymic processes in germination is sufficient to raise the temperature of the whole fermenting mass sufficiently to bridge the gap between 44° and 51° C.

A fuller account of these experiments is in course of preparation and will be published elsewhere. We are indebted to the Directors of Cadbury Brothers, Ltd., for permission to publish this communication.

[May 26.

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PHOTOSYNTHESIS BY ISOLATED CHLOROPLASTS

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THE many attempts to reconstruct photosynthetic events by systems less organized than whole green cells have met with success in only one area: the photolysis of water by chloroplast preparations resulting in the evolution of oxygen[1] (the Hill reaction). Evidence has now been obtained that whole chloroplasts, unaided by other cellular particles, have the ability to carry out two other photochemical reactions outside the living cell: (*a*) carbon dioxide fixation, and (*b*) photosynthetic phosphorylation, a term which we use for the conversion of light energy into the high-energy phosphate bonds of adenosine triphosphate (ATP), without the participation of respiration.

Although there are valid reasons for believing that the functioning photochemical mechanism in isolated chloroplasts, as measured by the evolution of oxygen, is the same as in the intact cell[2], there is uncertainty as to the manner in which light energy captured by chloroplasts is linked to carbon dioxide reduction. Until now, isolated chloroplasts appeared to differ from intact cells by being unable to link the photochemical evolution of oxygen to carbon dioxide fixation even when the latter was measured by the sensitive tracer carbon technique[3]. The Hill reaction proceeded only in the presence of non-physiological electron or hydrogen acceptors such as ferricyanide or quinone.

A step forward was the finding that, under proper conditions, illuminated, isolated chloroplasts can reduce the well-known physiological electron carriers triphosphopyridine nucleotide (TPN) and diphosphopyridine nucleotide (DPN)[4]. This permitted the linking of the Hill reaction to many enzymatic reactions, including carboxylations, which are dependent on reduced pyridine nucleotides. Indeed, the expectation that any enzyme system which uses reduced tri- or di-phosphopyridine nucleotide can do so whether the reduced coenzymes are produced by respiration or by illuminated chloroplasts was amply documented, particularly by the work of Vishniac and Ochoa[5]. These workers have also shown[6] that photochemically reduced diphosphopyridine nucleotide could be reoxidized by mitochondria from non-photosynthetic tissues and bring about the synthesis of adenosine triphosphate by an oxidative phosphorylation of the type observed by Lehninger[7].

Concepts, based on experiments with model enzyme systems, assigned to chloroplasts *in vivo* the limited functions of photolysis of water and the transfer of electrons and hydrogens to suitable acceptors, which were assumed to be pyridine nucleotides[8]. Carbon dioxide fixation proper and the conversion of light energy into the pyrophosphate bond-energy of adenosine triphosphate would, in this view, be carried out by mitochondria and soluble enzymes situated outside the chloroplasts. This concept was made plausible by the finding that in green leaves the malic enzyme, mediating the reductive carboxylation of pyruvate to malate, was in the cytoplasmic fluid[4,9,10]. Other carboxylases[10] as well as an important enzyme of the glycolytic cycle, glyceraldehyde phosphate dehydrogenase[11], were also found in the cytoplasmic fluid of green leaves rather than in the chloroplasts.

Our present findings, however, speak against this concept. Since washed chloroplasts were found to have the capacity, without the addition of other enzymes, to use light energy for adenosine triphosphate synthesis and carbon dioxide fixation, it follows that these particles contain the enzyme systems and at least most of the co-factors concerned in these reactions. The only added compound which gave consistently large increases in both photosynthetic phosphorylation and carbon dioxide fixation was ascorbic acid. The addition of di- or triphosphopyridine nucleotide, uridine triphosphate, cocarboxylase, thioctic acid or a mixture of thioctic acid and cocarboxylase was without effect on carbon dioxide fixation or photosynthetic phosphorylation. In the light of our present evidence, isolated chloroplasts emerge as remarkably complete cytoplasmic structures, equipped to carry out not only oxygen evolution but also carbon dioxide fixation and the conversion of light into chemical energy.

In setting out to investigate light reactions of isolated chloroplasts with reference to photosynthesis, our basic premise has been that only those chloroplast preparations which possessed the capacity for photolysis of water, as measured by oxygen evolution, were desirable objects of study. Isolated chloroplasts lacking this capacity are, so far as we know, incapable

of the primary conversion of light into chemical energy, and would therefore not be expected to participate in reactions involving carbon dioxide fixation. The dependence of phosphorylation and carbon dioxide fixation in whole chloroplasts on their capacity for photolysis was demonstrated by the use of *o*-phenanthroline, a powerful inhibitor of photolysis[12,13]. Chloroplasts inhibited in this manner were in our experience unable to synthesize adenosine triphosphate or to fix carbon dioxide. It is therefore difficult to interpret the relation to photosynthesis of carbon dioxide fixation by those chloroplast preparations reported by Fager[14], which retained only a negligible capacity for oxygen evolution.

Our first experiments showed (Table 1) that while the capacity for photolysis is a prerequisite, it is not the sole condition for active photosynthetic phosphorylation and carbon dioxide fixation. Whole spinach chloroplasts, prepared in 0·5 *M* glucose or 0·35 *M* sodium chloride, were found capable of carrying out all three reactions. Chloroplast fragments, which in these (Table 1) and previous experiments[13] retained an unimpaired capacity for photolysis, showed only feeble photosynthetic phosphorylation and practically no light-induced carbon dioxide fixation. Whole chloroplasts were therefore used in all subsequent experiments. The ratio of light to dark fixation was used as an index of photosynthetic activity. With good preparations of chloroplasts the ratio averaged about 160 for carbon dioxide fixation and 20 for phosphorylation.

Table 1. Photolysis, Photosynthetic Phosphorylation and Carbon Dioxide Fixation by Cell-free Preparations

All three reaction mixtures were in 3 ml. of 0·13 *M* tris (hydroxymethyl) amino methane, *p*H 7·2, and 0·35 *M* sodium chloride. Reaction time, 60 min. Temperature, 15° C. Gas phase, air. Special components were: photolysis–chloroplast material containing 0·5 mgm. chlorophyll and 7·4 μM *p*-benzoquinone; photosynthetic phosphorylation–chloroplast material containing 2 mgm. chlorophyll, 10 μM sodium ascorbate, 10 μM adenylic acid, 20 μM of a mixture of sodium and potassium phosphate, *p*H 7·2, containing 290,000 counts per minute (c.p.m.) of phosphorus-32. Carbon dioxide fixation–chloroplast material containing 2 mgm. chlorophyll, 10 μM sodium ascorbate, 20 μM of a mixture of sodium and potassium phosphate, *p*H 7·2, and 1·5 μM sodium carbonate containing *c.* $1{\cdot}5 \times 10^6$ c.p.m. of carbon-14

Preparation	Photolysis ($mm.^3 O_2$/hr./mgm. chlorophyll)	Photosynthetic phosphorylation (c.p.m. organic ^{32}P)		Carbon dioxide fixation (c.p.m. ^{14}C)	
		Light	Dark	Light	Dark
Leaf homogenate	340	4,900	3,140	60,600	3,140
Intact chloroplasts	480	4,250	950	52,000	238
Chloroplast fragments	400	1,100	300	1,100	1,000

Our results suggest an increasing order of complexity for the three photochemical reactions of isolated chloroplasts. Photolysis could be carried out by preparations incapable of photosynthetic phosphorylation and carbon dioxide fixation. In turn, photosynthetic phosphorylation was found to proceed unimpaired in the presence of potassium hydroxide when the partial pressure of carbon dioxide was extremely low. Carbon dioxide fixation, however, has so far been observed only under conditions which were compatible with active photolysis and phosphorylation.

The three photochemical reactions were separable by differential inhibition and by variations in the technique for the preparation of chloroplasts. Chloroplasts isolated in ethylene glycol retained their capacity for photolysis and photosynthetic

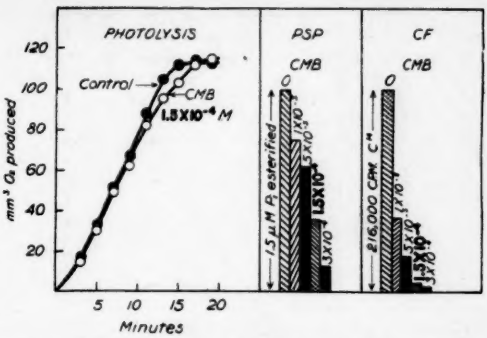

Fig. 1. Effect of *p*-chloromercuribenzoate (CMB) on photolysis, photosynthetic phosphorylation (PSP) and carbon dioxide fixation (CF) by isolated chloroplasts. Experimental conditions as in Table 1, except that gas phase in photolysis and carbon dioxide fixation was nitrogen, and phosphate was omitted in the latter reaction mixture

phosphorylation, but fixed practically no carbon dioxide. Using chloroplasts prepared in glucose or potassium chloride, we found that 2,4-dinitrophenol (8×10^{-4} *M*) was a strong inhibitor of both carbon dioxide fixation and phosphorylation, but that its effect on photolysis was rather mild. Iodoacetamide (2×10^{-3} *M*) inhibited carbon dioxide fixation about 97 per cent but had practically no effect on photosynthetic phosphorylation. As shown in Fig. 1, *p*-chloromercuribenzoate (CMB) was a strong inhibitor of carbon dioxide fixation, a less effective one of photosynthetic phosphorylation and had practically no effect on photolysis. This inhibition suggested the participation of sulphydryl groups in the chloroplasts. However, attempts to reverse the inhibition by the addition of cystein or glutathione were inconclusive since these compounds were themselves inhibitory.

An important difference between photosynthetic phosphorylation and carbon dioxide fixation was their response to anaerobiosis. As shown in Fig. 2, carbon dioxide fixation was increased under conditions of low oxygen tension, whereas photosynthetic phosphorylation was markedly inhibited. Anaerobic conditions were maintained by flushing the reaction vessels with nitrogen gas and having an 'Oxsorbent' solution (chromous chloride) in the side arm. These conditions would, of course, not exclude the very small quantity of oxygen (1 micromole at most) of photosynthetic origin newly liberated *in situ*.

The addition of adenosine triphosphate or of adenylic acid did not increase carbon dioxide fixation by isolated chloroplasts. A wholly unexpected finding was the inhibition of carbon dioxide fixation by the addition of inorganic phosphate (Table 2). These results suggest a competitive relation between photosynthetic phosphorylation and carbon dioxide fixation by isolated chloroplasts. It

Table 2. Effect of Added Inorganic Phosphate on Carbon Dioxide Fixation

Experimental conditions as in Table 1 except for phosphate

Exp. No.	Carbon-14 dioxide fixed (c.p.m.)	
	20 μM *Pi* added	*Pi* omitted
922	54,600	178,300
923	47,400	240,200
924	63,000	310,700
932	106,900	431,900

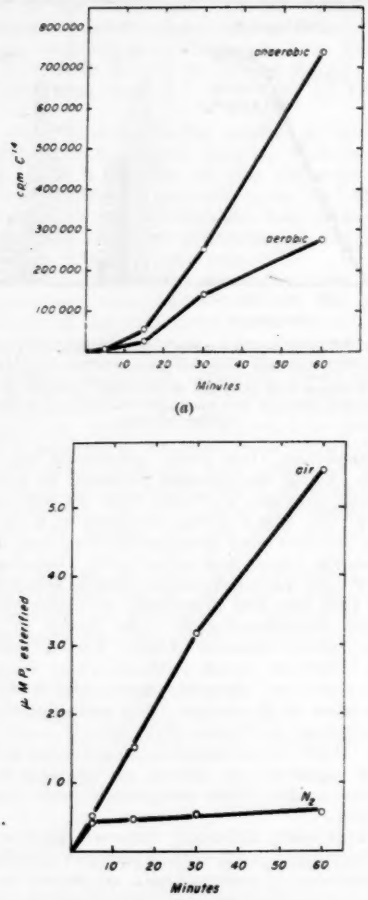

Fig. 2. Effect of anaerobiosis on (*a*) carbon dioxide fixation and (*b*) photosynthetic phosphorylation. Experimental conditions as in Table 1, except that phosphate was omitted in carbon dioxide fixation. Anaerobic conditions were provided by nitrogen gas and 0·2 ml. 'Oxsorbent' in the side arm of reaction vessel

seems prudent, however, to defer an interpretation of these data until results are obtained from other experiments now under way. Our chloroplast preparations contained measurable quantities of inorganic and organic phosphate. The identification, now in progress, of the products of carbon dioxide fixation by isolated chloroplasts in the absence of added phosphate should provide pertinent data on the relation between photosynthetic phosphorylation and carbon dioxide fixation by isolated chloroplasts.

Although the dependence upon oxygen of photosynthetic phosphorylation seems well established, the elucidation of the role of oxygen in this reaction must await further experimentation. Photosynthetic phosphorylation is not accompanied by manometrically measurable evolution of oxygen. The accompanying equations represent a tentative scheme of the course of the reaction, in accordance with experimental facts now known.

AMP and P_i represent adenosine-5-phosphate and orthophosphate (labelled with phosphorus-32).

$$(1)\quad H_2O \xrightarrow[\text{chloroplasts}]{\text{light}} 2e + 2H^+ + \{O\}$$

$$(2)\quad AMP + 2P_i + 2e + 2H^+ + \{O\} \rightarrow ATP + H_2O$$

$$\text{Sum: } (3)\quad AMP + 2P_i \xrightarrow[\text{chloroplasts}]{\text{light}} ATP$$

Adenosine diphosphate was found equally effective. The brackets around the oxygen in reactions (1) and (2) are intended to denote that it has not yet been determined whether: (*a*) oxygen is released in reaction (1) and immediately consumed in reaction (2), or (*b*) whether the oxygen in reaction (1) represents the formation of some oxidized substance within the chloroplast which is reduced by electrons in accordance with equation (2). In this connexion the recent observation by Lundegårdh[15] of the oxidation of cytochrome *f* in green cells on exposure to light is of special interest.

Adenosine triphosphate was identified as the product of reaction (3) (*a*) directly, by adsorption on 'Norite' followed by hydrolysis of labile phosphate, and (*b*) indirectly, using hexokinase and glucose as an adenosine triphosphate acceptor system either during the progress of photosynthetic phosphorylation or following the termination of the reaction and the chemical isolation of adenosine triphosphate. In both cases the product of the hexokinase reaction, glucose-6-phosphate, was identified chromatographically.

The photochemical esterification of inorganic phosphate by chloroplasts, independent of carbon dioxide fixation, provides a mechanism for converting light energy into adenosine triphosphate, without the utilization of energy released by reoxidation of partly or wholly reduced products of carbon dioxide fixation[16]. Both photosynthetic phosphorylation and carbon dioxide fixation by isolated chloroplasts are novel findings which require careful documentation. The conclusions presented here are based on forty-three consecutive experiments with isolated chloroplasts in which photosynthetic phosphorylation and carbon dioxide fixation were observed without a single exception. A full account of these experiments will be presented elsewhere.

This investigation was aided by a grant from the U.S. Public Health Service. [May 19.

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LETTERS TO THE EDITORS

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Trace Analysis by X-Ray Emission Spectrography

We have used X-ray emission spectrography[1] (X-ray fluorescence) for rapid and accurate direct analysis of small quantities of material by a technique resembling that of the familiar spot test[2]. Our results on zinc (Fig. 1) show the simplicity and speed of the method.

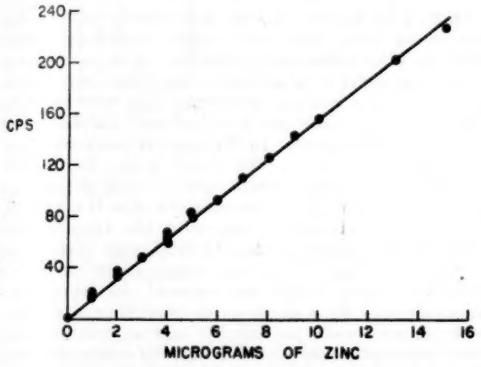

Fig. 1. Counting-rate of zinc $K\alpha$ line for various amounts of zinc on Schleicher and Schuell No. 740*E* ½-inch disks. Samples prepared by placing measured amounts of zinc sulphate solution on the paper and drying to remove the water

The samples containing zinc were dissolved and the solutions dispersed over a well-defined area that could be placed completely in the X-ray beam. As a carrier for the dispersion, Schleicher and Schuell bioassay paper (No. 740*E*) or Whatman's No. 50 filter-paper worked well. The thinness and rigidity of the paper simplified the problem of keeping the sample at the proper place in the X-ray system; other carriers, however, can be used. The intensity of the zinc characteristic $K\alpha$ radiation above the surrounding background gave the direct quantitative measure of the zinc content. Typically, 15·6 counts/sec. of zinc $K\alpha$ radiation per microgram were observed above a background of 49·7 counts/sec. using the bioassay paper. With the filter-paper the background was only 15 counts/sec. The reduced background decreased the time necessary for the detection of 1/30 microgram of zinc from 7 to 2 min. counting time. Different samples of paper gave varying backgrounds, with a standard deviation of 3 counts/sec., which made it possible to determine the larger zinc concentrations without a separate background determination.

Fig. 1 shows the accuracy of the method for numerous samples; the linear range extends to 100 μgm. before absorption effects introduce curvature. The same technique was used for the determination of small amounts of vanadium, copper, iron, silver, bromine, gold, and lead with standard deviations of well under 1 microgram for a determination taking 10 min. or less.

We have increased the sensitivity by counting for longer times. Care is necessary, however, because long-time fluctuation in the X-ray equipment can cause difficulty. Therefore, we have used a commutation method in which the sample and background are counted alternately until the desired number of counts is accumulated.

The samples we used are thin—a microgram of zinc spread over 1 sq. cm. is only 3 atoms or about 10 A. thick; radiation produced in such a thin layer will be essentially unaffected by the presence of other atoms in like quantities. It should therefore be possible to analyse mixtures without concern for the interferences that occur in the X-ray emission spectrographic analysis of bulk materials.

Except for the rather rare overlapping of X-ray lines, the components of mixtures will respond independently, and no previous chemical processing beyond dispersing the sample is required.

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Visibility of X-Ray Quantum Fluctuations on Image Intensifier Radiographs

The gain in brightness with an X-ray image intensifier is accompanied by a more or less disturbing effect, namely, the visibility of a kind of visual 'noise', especially when the X-ray intensity is low, the intensification factor of the intensifier is high (greater than 1,000 times) and the optical magnification of the final image large.

In intensifier radiography, in certain circumstances a coarse mottling is observed on the photographic image of the viewing screen. In Fig. 1, four prints are shown of intensifier radiographs (original size 5 mm. diameter) on Agfa Fluorapid film. An object

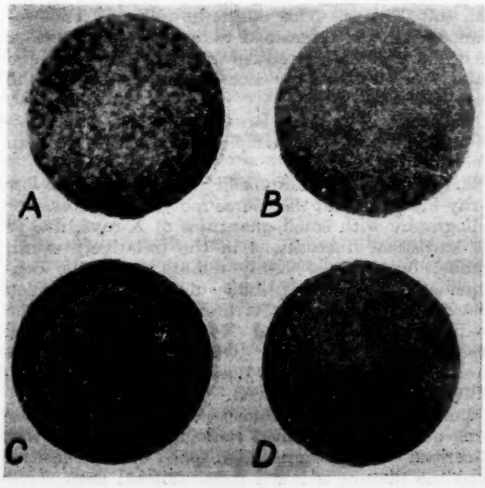

Table 1

Photo	Charge (mA.sec.)	Relative exposure time	No. of developed grains per X-ray quantum absorbed
A	0·006	1	32
B	0·030	5	6
C	0·19	32	1
D	0·96	160	0·2

equivalent to 8 cm. of water was placed between the X-ray tube and the image intensifier. The pictures were taken at 67 kV., focal distance 90 cm. The difference between the radiographs is the amount of X-ray energy detected per picture. By varying the speed of the optical system with an aperture, an equal density of 0·75 on the original radiographs was obtained.

In Table 1 are given for each picture the X-ray energy which is proportional to the electrical charge (mA.sec.) through the X-ray tube, the relative exposure times and the approximate number of silver grains per absorbed X-ray quantum. Though the film material and the density were the same, the structure of the pictures is quite different. The mottling of the image decreases with increasing current. The intrinsic film graininess is reached when the number of X-ray quanta necessary for producing one silver grain exceeds 1.

The explanation is as follows: on picture *A*, taken with a small quantity of X-rays, every absorbed X-ray quantum gives rise, due to the intensification, to the development of a cluster of 32 silver grains in the film emulsion. The mottling of the radiograph is determined by a statistical distribution of grain clusters, the dimensions of which are determined by the circle of diffusion of the intensifier X-ray screen. The number of grains in one cluster is given by the last column of Table 1. As the number of clusters per unit area in picture *A* is considerably smaller than the number of separate grains in picture *D*, the grain distribution in picture *A* deviates much more from a homogeneous distribution than that in picture *D*, due to the larger relative statistical fluctuations in the number of clusters.

A similar effect has been observed by Eggert and Schopper[2] when taking full-size radiographs with X-rays of different hardness. The picture with hard X-rays seems to be more grainy than the photo with soft X-rays. This effect, however, is less pronounced than on intensified radiographs, because on an ordinary full-size radiograph only two to three grains are developed for each X-ray quantum of the same energy.

Recently, Cope and Rose[3] published an X-ray noise picture, using a photoconductive pick-up tube.

The visual 'noise' in intensifier fluoroscopy with low X-ray intensity and the coarse mottling in intensifier radiography with small quantities of X-rays, due to the statistical fluctuations in the (relatively small) number of absorbed X-ray quanta, have the consequence that the perceptibility of detail on intensified images and radiographs is limited. This has been predicted by Sturm and Morgan[4] and confirmed experimentally by us[5]. Only by increasing the number of X-ray quanta detected can the perceptibility of detail be improved.

Summarizing, the influence of quantum fluctuations on image-intensified radiographs is such that in certain circumstances (high-speed optics, sensitive film) the picture is much more mottled than corresponds with the normal intrinsic graininess of the photographic emulsion.

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April 20.

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Velocity of Electron Pulses

One of us[1] has noted that the velocity of electrons has never been measured under conditions which allow no alternative interpretation. A linear velocity of displacement is a necessary inference only where two successive events, departure and arrival, have been observed which are localized and distinct, both in space and in time. In the known determinations with static or periodic deflecting fields one cannot discriminate between *transit times* of localized entities and *vibration periods* of extended systems. It appeared, therefore, of interest to determine the transit time, across a measured distance, of a brief pulse of electrons of known energy. This was achieved by using two deflector gates, which are opened for very brief intervals only by a single surge travelling in a cable, with an accurately measurable and adjustable delay time, corresponding to the length of cable, between the opening of the first gate and of the second.

A sketch of the apparatus is shown in Fig. 1. An electron gun directs a fine beam of 2 kV. electrons into the top deflexion chamber. At the start the beam is deflected by a static potential of 1·1 kV. on the cable core, so that the gate is closed. The voltage is reversed by a vacuum switch, which sends two travelling waves to the gates. The top gate opens first, at an instant when the potential of the deflector electrode connected with the cable core passes through zero. By using fine apertures, the opening time can be reduced to about 10^{-10} sec. A group of electrons passes through the small exit aperture, and is focused by a magnetic lens on the entrance aperture of the second gate, so that no electrons are lost in the transit. The opening pulse at the second gate is delayed by a length of polythene cable; the delay can be accurately adjusted by means of a sliding branching-point. If the electrons are monokinetic, and if the delay in the cable is equal to the transit time, practically all electrons which have passed through the first gate will also pass through the second. They are collected by a nine-stage beryllium–copper electron multiplier, which we owe to the courtesy of Dr. Alexander Baxter (Cambridge), with a gain of the order 100,000. Using three valve-amplifier stages, pulses of less than fifty electrons could be easily observed on the screen of a cathode ray tube, and the noise-level was so low that spontaneous pulses of this order occurred only a few times per minute.

The results completely confirmed the orthodox expectations. By moving the branching-point, it could be ascertained that about 90 per cent of the electrons arrived within $\pm$ 1 per cent of the mean transit time; and the most probable transit time,

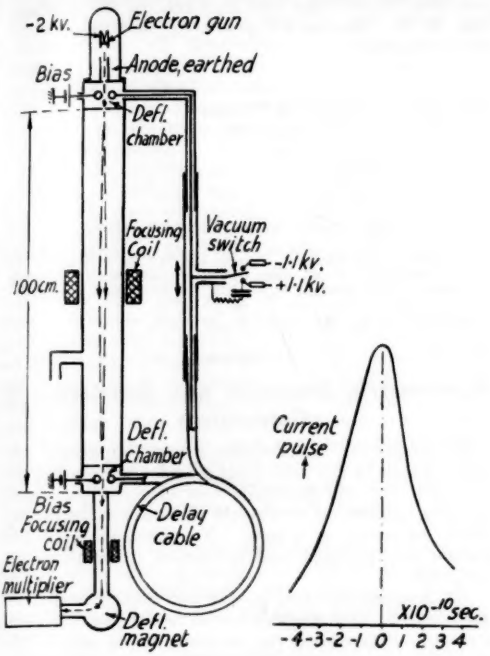

Fig. 1

Fig. 2

that is to say, the position of the current peak in Fig. 2, could be ascertained within ± 0·25 per cent. The corresponding delay in the cable agreed with the calculated electron transit time within about 1 per cent, which is inside the error limit due to the calibration of the cable, and of the measurement of the accelerating voltage. The scatter in the electron arrival (Fig. 2) can be accounted for by the fluctuations in the high-voltage source and by the opening characteristic of the gates. The position of the maximum could be ascertained in a range of ± 5 mm. shift of the branching-point, corresponding to a time uncertainty of 3×10^{-11} sec. We estimate that by using a stabilized voltage source, finer apertures and a thirteen-stage multiplier this could be reduced by an order of magnitude. It appears, though, that the experiments, as they stand, constitute a sufficient *a posteriori* justification of velocity measurements using periodic fields.

The apparatus was so devised from the start that, once this confirmation was obtained, it could be used as a velocity spectrograph, and as a chronograph for measuring the time of rise of very steep surges. If one of the gates the deflecting electrode opposite to the one which is energized by the surge is biased by, say, ± 100 V., the moment of opening will be delayed or advanced by the time which the potential in the wave-front takes to rise by 100 V., and the other gate must be correspondingly delayed or advanced in order to pass the maximum current. It was found that the time of rise for 100 V. in a surge of 2·2 kV. total, initiated by a vacuum switch, was 3×10^{-10} sec., and no significant difference was found between the slope at the top gate and at the bottom gate due to damping by the polythene cable. This figure must be considered as giving a lower limit only for the slope, as no particular care was taken in matching the deflecting chambers to the cable.

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Orientation of Apatite Crystals in Bone

From the earliest experiments on X-ray diffraction by specimens of bone, it has been well known that in long bones, for example, femora, the *c*-axes of the hexagonal apatite crystals are preferentially orientated parallel to the long axis of the bone. In regard to sections of bones cut normal to the long axis, no one has reported any preferential orientation of the crystals. In fact, it has been repeatedly stated in the literature that there is no orientation of the crystals in the plane perpendicular to the long axis[1].

During the past few years we have been studying the crystal structure of bones in relation to growth, and as part of this research we have investigated sections cut perpendicular to the long axes of the femora of rats of all ages. The sections were cut near the middle of the bone by means of a section-cutting machine similar to that described by Atkinson[2]. They were approximately 0·006 in. thick and were mounted in a miniature X-ray camera of the Chesley type[3]. In every specimen examined we have found that the apatite crystals are always preferentially orientated with the *c*-axis approximately tangential to the surface of the bone. A systematic investigation was carried out as follows.

A reference line was marked on the collimator holder which also carried the specimen, and a corresponding line was marked on the film. The collimator with specimen attached was mounted on the stage of a microscope and a beam of light passed through the collimator (diam. 0·01 cm.) so that a bright spot of light was seen at the point on the specimen where the X-ray beam would strike. A photograph was taken with a magnification of 18 times, so that for each X-ray photograph the exact spot where the X-ray beam passed through the specimen was known as well as the orientation of the specimen with respect to a reference line on the film. After each X-ray exposure the specimen was moved and another photomicrograph taken until a series of exposures had been taken at points all round the hollow sections.

The 002 powder ring appears as two strong arcs and the position of these arcs moves around the powder ring as the point irradiated moves around the annulus of bone. (The much weaker 004 ring is similar.)

The angle which the line joining the middle of the arcs makes with the reference line was measured on each photograph. This is the preferred direction of the *c*-axis of the apatite crystals. A tracing of the outline of the bone section was made from one of the photomicrographs and the successive points irradiated were marked on it. From each of these points a line was drawn perpendicular to the tangent to that part of the bone surface nearest to the point considered. For each photograph the preferred *c*-axis direction was drawn on the tracing and the angle it makes to the 'radial' lines measured. If the direction of

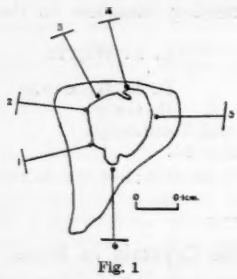

Fig. 1

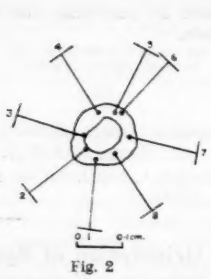

Fig. 2

Fig. 1. Outline of cross-section of rat femur (age 4 months) showing positions where X-ray diffraction photographs were taken and corresponding directions of preferred orientation of *c*-axes of apatite crystals

Fig. 2. As for Fig. 1 (age 10 days)

preferred orientation is tangential, these angles should be 90°.

Two examples are illustrated. Fig. 1 is a section of a femur of an adult rat (four months) and the angles are respectively as follow:

(1) 90°, (2) 79°, (3) 87°, (4) 83°, (5) 85°, (6) 87°.

Fig. 2 is a section of the femur of a young rat (ten days) and the angles in this case are:

(1) 87°, (2) 88°, (3) 89°, (4) 88°, (5) 90°, (6) 86°, (7) 87°, (8) 89°.

In view of the difficulty of drawing accurate tangents to the non-regular surfaces, it seems well established that the apatite crystals in the cross-section of the rat femora are preferentially orientated with the *c*-axis tangential to the surface of the bone.

When photographs of a longitudinal section are compared with those of a cross-section, it is clear that the intensity of the 002 arcs in the latter is much less than in the former. It seems, therefore, that in the bone shaft as a whole the majority of crystals are arranged with their *c*-axes approximately parallel to the long axis of the bone; but of those crystals which are lying with their *c*-axes in the cross-sectional plane, most are arranged with the *c*-axes tangential to the surface. Fig. 3 shows X-ray diffraction photographs of (*a*) a longitudinal section with X-ray beam perpendicular to the long axis, (*b*) a cross-section of the same specimen with X-ray beam parallel to the long axis of the bone (position No. 3 of Fig. 1); copper $K\alpha$ radiation, specimen-to-film distance 1 cm. The 002 reflexion which shows pronounced arcs in both photographs is inside the strong continuous ring.

We are indebted to Prof. A. Haddow, of the Chester Beatty Research Institute, London, for a supply of pure-line Wistar rats and to Prof. G. H. Bell and Miss M. H. Thomas for providing us with most of the specimens.

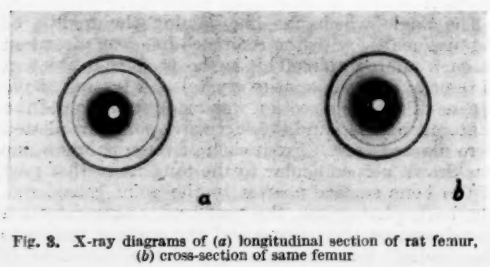

Fig. 3. X-ray diagrams of (*a*) longitudinal section of rat femur, (*b*) cross-section of same femur

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Fluorometric Detection and Estimation of Germanium

Fluorometry has become a very important tool in the hands of the analytical chemist in recent years not only for the detection but also for the quantitative estimation of several substances, especially those occurring in traces. Nevertheless, very few metals are detected and estimated by fluorometric methods.

No fluorometric test has so far been reported for germanium. This element has in recent years attained strategic importance on account of its use in the manufacture of transistors and on account of its scarcity. We have now found that traces of germanium give an intense greenish-yellow fluorescence with a solution of resacetophenone in concentrated sulphuric acid or syrupy phosphoric acid under filtered ultra-violet light. No other metal interferes.

Borate gives a blue fluorescence with this reagent, as already reported by Neelakantam and Row[1]. Nitrite, nitrate, fluoride and chromate quench the fluorescence given by germanium in both the sulphuric and phosphoric acid media. Bromide, iodide and chlorate quench the fluorescence in the sulphuric acid medium but not in the phosphoric acid medium. When sulphuric acid is employed, the solution acquires a brownish colour, which deepens on standing.

We recommend the following method for the fluorescence test for germanium. The resacetophenone reagent is prepared by dissolving 0·5–1·0 gm. of the pure substance in 100 ml. of acetic acid. To 3 ml. of this reagent in a quartz test-tube is added 6 ml. of syrupy phosphoric acid. 0·1–1·0 ml. of the germanium solution is now run in and mixed, adding some more syrupy phosphoric acid, if necessary, to make up the total volume to 10 ml. Then the test-tube is kept exposed to ultra-violet light from which all visible light has been filtered out; for this purpose we have used the 'Cenco Black Light' source operating on 220-V. a.c. mains. The intensity of the greenish-yellow fluorescence has been found to vary with the concentration of the germanium ions. The limit of sensitivity is 1 : 10,000 and the limit of identification 100 γ.

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Synthesis of (±) Methyl Fluoromalate

THE observations of Peters *et al.*[1] that the administration of fluorocitrate resulted in the inhibition of the tricarboxylic acid cycle suggested the synthesis of other fluorinated acids of biochemical interest. In this preliminary communication, we wish to report the synthesis of (±) methyl fluoromalate and fluoromalamide.

Ethyl ethoxalylfluoroacetate, prepared according to Rivett's method[2], was reduced with potassium borohydride (two equivalents) in absolute methanol with vigorous stirring. The temperature of the reaction mixture rose to 50° during the reaction, which was complete after 90 min. Excess dry methanolic hydrogen chloride was added and the filtered solution distilled with repeated addition of methanol to remove methyl borate. The remaining solution was neutralized with lead carbonate, filtered and dried (sodium sulphate). Removal of the solvent furnished (±) methyl fluoromalate (transesterification having taken place during the reactions) as a colourless viscous liquid. The ester gave negative tests for carbonyl groups, a positive test for hydroxy groups and had the following microanalytical composition: C, 40·0; H, 5·8 per cent. $C_5H_9O_5F$ requires C, 40·1; H, 5·1 per cent.

The reduction of ethyl ethoxalylfluoroacetate with lithium aluminium hydride and aluminium *iso*propoxide was also attempted; but preliminary experiments gave much poorer yields of the ethyl fluoromalate.

(±) Methyl fluoromalate was identified by converting it into the diamide with saturated methanolic ammonia for 48 hr. The fluoromalamide was recrystallized from *iso*propyl alcohol (m.p. 160° uncorr.). A mixed melting point with malamide[3] (m.p. 162° uncorr.) gave a depression (m.p. 130° uncorr.). Fluoromalamide exhibited an absorption band at 1,050 cm.$^{-1}$ which was attributed to the C–F bond and gave the following micro-analytical results: found: C, 32·1; H, 4·4; N, 18·8 per cent. $C_4H_7O_3N_2F$ requires C, 32·0; H, 4·65; N, 18·7 per cent.

The results of biochemical assay[4] and details of this work will be published elsewhere. We thank Dr. E. M. Gal for his advice and interest in these experiments.

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Reversal and Mechanism of Oxidative Phosphorylation

THE importance of reactions in which electron transport from reduced pyridine nucleotides to oxygen is coupled with the formation of adenosine triphosphate from adenosine diphosphate and inorganic phosphate is well recognized by biochemists. Although much pertinent information has been accumulated, no clear picture of the sites and mechanism of uptake of inorganic phosphate coupled with electron transport has yet been obtained. This communication gives some results of exchange reactions of inorganic phosphate labelled with phosphorus-32 and oxygen-18 which may give some additional insight concerning oxidative phosphorylation, together with a brief presentation of a hypothesis for the mechanism of coupling of electron transport with inorganic phosphate uptake.

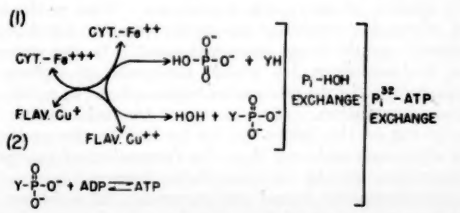
EXCHANGE REACTIONS CATALYSED BY LIVER MITOCHONDRIA IN THE ABSENCE OF ADDED SUBSTRATE

Oxygen uptake	<0·05	μM
Inorganic phosphate (phosphorus-32) – ATP exchange		
Total phosphorus-32 added	3,670	c.p.m.
Total phosphorus-32 found in ATP	820	c.p.m.
Amount of reaction, $^{32}P_i \rightleftharpoons$ ATP	14	μmoles
Inorganic phosphate – oxygen-18 exchange		
Initial atom % excess oxygen-18 in inorganic phosphate	0·278	
Final atom % excess oxygen-18 in inorganic phosphate	0·063	
Amount of reaction, $P_i - {}^{18}O \rightleftharpoons$ HOH	280	μ atoms

Each Warburg flask contained 21 $\mu M K^+$ – ATP, 21 μM $MgSO_4$, 150 μM KCl, 150 μM sucrose, 45 μM inorganic phosphate (phosphorus-32 or oxygen-18) and washed liver mitochondria from fasted rats from 0·5 gm. fresh liver. Flasks were incubated 5 min. at 23° before addition of the inorganic phosphate-32 and measurement of oxygen uptake. Reaction time, 15 min.

Various considerations suggested that oxidative phosphorylation under suitable conditions might be a demonstrably reversible process. Prominent among these was the unexplained observation of Cohn[1] that in the presence of tissue preparations carrying out oxidative phosphorylation the oxygen of phosphate was rapidly exchanged with that of water. Subsequent experiments reported briefly herein have shown that liver mitochondria preparations in the absence of added substrate and net oxygen uptake will catalyse a rapid exchange of inorganic phosphate–^{32}P with adenosine triphosphate accompanied by a very extensive exchange of the oxygen atoms of inorganic phosphate as measured with oxygen-18. Results of a typical experiment are shown in the accompanying table. Although there was little net change in the concentrations of adenosine triphosphate and inorganic phosphate, extensive exchange had occurred and the two substances appeared to be in equilibrium. The total micromoles of inorganic phosphate which was incorporated into and released from adenosine triphosphate was calculated on the basis of the expected exponential approach to isotopic equilibrium, with the assumption that two phosphate groups of the adenosine triphosphate were available for equilibration with inorganic phosphate.

The exchange of approximately twenty atoms of phosphate oxygen for each atom of inorganic phosphate incorporated into adenosine triphosphate shows clearly that reversal of the overall reaction $P_i + ADP \rightleftharpoons ATP + H_2O$ could account for only one-twentieth of the oxygen exchange observed. The demonstration of the reversibility of the overall reaction does suggest, however, a satisfactory explanation for the observed oxygen exchange. If, as depicted in the accompanying scheme, the initial reaction or reactions of oxidative phosphorylation accompanying electron transport involve loss of an oxygen from inorganic phosphate, reversal of these



An explanation of $^{32}P_i$—ATP and P_i—HOH exchange. Overall: ADP + $^{32}P_i \rightleftharpoons$ ATP + HOH

reaction(s) would lead to exchange of the inorganic phosphate oxygens with water. Inorganic phosphate under equilibrium conditions would be expected to pass through the initial reaction(s) at a rate equal to or greater than through the subsequent reaction(s). Thus exchange of inorganic phosphate oxygen could be much more extensive than exchange of inorganic phosphate with the phosphate of adenosine triphosphate.

Evidence that the phosphate oxygen exchange probably does not result from transfer of the phosphate moiety after its initial uptake comes from observations that no phosphate oxygen exchange accompanies the phosphate transfer reactions of the adenylic system which have been measured[2], and from further experiments with liver mitochondria using oxygen-18. The latter experiments have shown that when phosphate is cleaved from adenosine triphosphate by liver mitochondria in the presence of 2,4-dinitrophenol, only the expected incorporation of approximately one oxygen from water into the inorganic phosphate formed was found. When inorganic phosphate – ^{18}O was transferred to adenylic acid to give adenosine triphosphate by mitochondria oxidizing alpha-ketoglutarate, the phosphate derived from the adenosine triphosphate formed had exchanged only 1·6 atoms of oxygen per phosphate; this exchange may have resulted from some reversal of the initial step(s) of the phosphate uptake at the site of phosphorylation in the mitochondria. This is in marked contrast to the extensive oxygen exchange under apparent equilibrium conditions as shown in the table.

The exchange reactions measured with phosphorus-32 and oxygen-18 were almost completely abolished by the presence of 3×10^{-4} *M* 2,4-dinitrophenol, which gives evidence in support of the suggestion that the exchange results from a reversal of phosphorylation coupled with electron transport. The unlikely possibility that the exchange of inorganic phosphate – ^{32}P was a result of reversal of hydrolytic cleavage of adenosine triphosphate was eliminated by the finding that 'adenosine triphosphatase' prepared from mitochondria according to Kielley and Kielley[3] did not catalyse the incorporation of inorganic phosphate – ^{32}P into adenosine triphosphate under conditions similar to those used for experiments reported in the table. Thus for the exchange of inorganic phosphate and adenosine triphosphate to occur, energy derived from the cleavage of the phosphate moiety from the latter must be preserved either by reduction of a component of the respiratory chain or in the form of a 'high-energy' intermediate.

If the explanation for the marked oxygen exchange is valid, and since 2,4-dinitrophenol abolishes this exchange, it follows that 2,4-dinitrophenol either dissociates electron transport from the initial inorganic phosphate uptake or causes breakdown of a 'high-energy' intermediate before the reaction leading to uptake of inorganic phosphate. The activation of adenosine triphosphate hydrolysis by 2,4-dinitrophenol[4] would be an expected result. In the reversal of the reactions by which inorganic phosphate is incorporated into adenosine triphosphate in oxidative phosphorylation, the energy derived from the splitting of the latter would be lost in the presence of dinitrophenol and thus the formation of inorganic phosphate would be essentially irreversible.

Explanations based on experimental evidence as to how transport of electrons through the cytochrome system might be coupled with phosphate uptake have been singularly lacking. Recent fundamental studies of Taube and associates[5] may give information pertinent to biological oxidations; for example, they have found that in the oxidation of chromous ion by ferric iron catalysed by chloride ion, the activated complex contains a chloride ion as a 'bridge' between the two metallic ions. The initial oxidation product is chromic chloride, which is thermodynamically unstable and reacts with water with liberation of the chloride ion. By analogy, the hypothesis is advanced that transport of electrons from metalloflavoproteins (for example, butyryl coenzyme A dehydrogenase[6]) to a cytochrome involves participation of a 'bridge' atom between the metal of the flavoprotein and the cytochrome iron, or, similarly, between an intermediate and the iron of cytochrome oxidase. The bridge atom might be a sulphur, an oxygen of phosphate or dinitrophenol, or a group on a cytochrome. The compound formed after electron transfer would be a 'high-energy' phosphate or be cleaved by inorganic phosphate to give a 'high-energy' phosphate. Phosphate-bond energy might thus be used to reverse the direction of electron transport. The hypothesis leads to a satisfactory, but by no means the only possible, explanation of the findings reported here.

Details of these and related experiments will be given elsewhere. This work was supported by grants from the National Science Foundation and U.S. Public Health Service.

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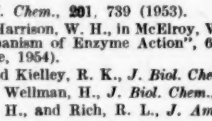
Barbiturate Antagonism

In a previous communication[1], we reported the discovery of the antagonism which certain substances exhibited towards morphine but not towards barbiturates. One of these substances was 2-4 diamino 5 phenyl thiazole. We wish to report now the discovery of a compound which is a barbiturate antagonist, and at the same time to link this antagonism with that of morphine by means of 2-4 diamino 5 phenyl thiazole (which has now been shown to be slightly antagonistic to barbiturates).

The barbiturate antagonist is ββ methyl ethyl glutarimide (designated *NP*13).



Rats and Mice. Two groups of twelve animals were taken and pentobarbitone (60 mgm./kgm.) injected intraperitoneally. To one group *NP*13 (100 mgm./

kgm.) was given by the same route. The average sleeping time of the test group was reduced to about half (a t test gave $P < 0{\cdot}01$). A similar antagonism to barbitone and phenobarbitone was demonstrated. *NP*13 (15 mgm./kgm.) itself caused convulsions which at 30 mgm./kgm. were fatal. Treatment of the animal with pentobarbitone before or after injection of *NP*13 prevented these convulsions.

Cats. These animals were aroused to a state of reflex activity and semiconsciousness from the narcosis of pentobarbital (60 mgm./kgm.). In the case of mice, rats, dogs and rabbits, *NP*13 brought about a return to consciousness from deep anæsthesia. This, however, could not be achieved with cats, and only a marked decrease in depth of anæsthesia resulted. In this respect cats behaved in the same manner as human beings (see below).

*NP*13 was effective orally, as well as by intravenous or intraperitoneal routes. It was also observed to have marked stimulating action on the barbiturate-depressed respiration, the rate being as much as doubled for a period of 5–10 min. after injection.

Rabbits. Each member of a group of six rabbits was given sufficient thiopentone (0·5 per cent) intravenously to induce a desired degree of anæsthesia. The mean duration of anæsthesia for the group was obtained. On a subsequent day the experiment was repeated, except that at the end of the thiopentone injection 3-ml. portions of a 0·6 per cent solution of *NP*13 were injected until the animal regained consciousness. The mean duration was again noted. A t test revealed a marked shortening of anæsthesia ($P < 0{\cdot}01$). Again the ability of *NP*13 to increase the barbiturate-depressed respiration was noted.

The individual dose of thiopentone to depress the respiration to 12 per minute was determined from six animals. This dose was then increased by one-third. At the end of administration of the augmented dose of thiopentone, *NP*13 was given until the animals recovered. Several days later the augmented dose alone was given; all six animals died.

*NP*13 injected alone produced convulsions which could be controlled by thiopentone.

Dogs. Six tantalum electrodes were inserted through the skull in a series of eight dogs, insulated with polyethylene and kept in position with stainless steel wire. Later, electroencephalogram records were taken. By this means it was possible to obtain a control electroencephalogram of the normal dog followed by the change in pattern as the pentobarbital took effect. Then the return towards normal produced by the intravenous injection of *NP*13 could be observed—likewise the effect of overdosage of this substance. Several experiments were carried out on each animal.

*NP*13 reversed the pentobarbital narcosis, restoring the animal to consciousness. Overdosage resulted in fasciculation, convulsions and the appearance of spikes in the electroencephalogram. The safety margin was, however, large. In none of our experiments (about twenty), despite deliberate overdosage, were there any fatalities.

We have also shown that 2-4 diamino 5 phenyl thiazole reverses the narcotic effects of pentobarbital, its action in this respect being much inferior to that of *NP*13. This substance, however, synergizes with *NP*13, the mixture giving especially greater respiratory stimulation than *NP*13 alone. Further, the convulsive effects of *NP*13 are counteracted by the thiazole.

Man. We have been fortunate in terminating the coma of some twenty cases of barbiturate poisoning with a mixture of *NP*13 and thiazole. The details of these cases will be reported fully in a clinical journal[2].

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Metabolism and the Occurrence of *d*(−)Glutamic Acid in Tumour Proteins

Several investigators[1], using isotope techniques, have failed to reproduce Kögl's results on the *d*(−)glutamic acid content of tumour proteins. All such experiments were based on the hydrolysis of tumour proteins with concentrated hydrochloric acid. Kögl tried to explain the discrepancies as due to differing methods of hydrolysis[3]; but strangely enough, Kögl's feeding experiments have never been repeated. In 1940, Kögl was able to isolate, after hydrolysis, *d*(−)glutamic acid from the fæces of a dog which had been fed with Brown–Pearce tumour tissue; in 1948, he obtained in a similar way pure *d*-pyrrolidonic acid after feeding tumour protein[3] using the method of Ratner, that is, extraction of the urine with ethyl acetate at *p*H 2 and precipitation with barium[4]. No objections can be raised to these methods.

We have now repeated these feeding experiments employing Ratner's procedure. After feeding 1,500 gm. of human liver metastases isolated by hand to rats, 190 mgm. of pure *d*-pyrrolidonic acid was obtained in crystal form from their urine. The ethyl acetate residue, after removal of pyrrolidonic acid, yielded a dipeptide containing *d*(−)glutamic acid. Its presence and composition were shown, after coupling with dinitrofluorbenzene, by paper chromatography and infra-red spectroscopy (we are indebted to Dr. Schiedt, Max Planck Institut für Biochemie, for measuring the infra-red spectrogram), and after hydrolysis and paper chromatography by the microbiological method of Ayengar and Roberts[5] (incubation of the material with acetone-dry powder of *E. coli* E26 (Iowa State College) test for *d*(−)glutamic acid in the presence of γ-aminobutyric acid from decarboxylated *l*(+)glutamic acid). Other feeding experiments with two human liver metastases did not yield any crystallized *d*-pyrrolidonic acid; but the micro-method mentioned above indicated clearly the presence of *d*(−)glutamic acid. After feeding rats with human liver, beef, bread or grain equal in amount to the tumour tissue used in experiments described here, we were never able to isolate pyrrolidonic acid or to detect *d*(−)glutamic acid after ethyl acetate extraction and barium precipitation following careful hydrolysis with hydrochloric acid. However, after direct careful hydrolysis of the ethyl acetate residue with 20 per cent hydrochloric acid (1 hr. on steambath) and separation over 'Amberlite

IR-4B', we were able to show by paper chromatography the presence of small amounts of *d*(−)glutamic acid which were not due to racemization.

In order to investigate whether this *d*(−)glutamic acid arose from ordinary food proteins, the urine of starved rats was analysed. *d*(−)Glutamic acid could readily be shown to be present, employing the procedures described above. The same result was obtained with human urine. We are now trying to determine differences in the *d*(−)glutamic acid content of urine from patients with different diseases.

Since we have found *d*(−)glutamic acid in the urine of starving humans and rats, it may well be that account must be taken of the presence of 'unphysiological' *d*-amino-acids in ordinary metabolism; this would seem to us to explain the so far ambiguous role of *d*-amino-acid oxidases.

Details of this work will be published in the *Zeitschrift für Naturforschung*.

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Influence of Carbon Dioxide on the Toxicity of Ammonia

Rivers polluted with sewage effluent may contain low concentrations of dissolved oxygen at places where the concentrations of ammonia and carbon dioxide are relatively high. It is known that both ammonia and carbon dioxide are toxic to fish in high enough concentration, and that they are rendered more toxic by lowering the concentration of dissolved oxygen[1,2]. A study of the toxicity to fish of water containing both these substances when the concentration of dissolved oxygen was low, but not lethal, was thought desirable.

Sufficient ammonium chloride to give concentrations equivalent to 0, 15 and 30 parts of nitrogen per million was added to tap water at Garston, Watford. A mixture of oxygen, nitrogen and carbon dioxide was blown through the solutions to maintain the concentration of dissolved oxygen as close as possible to 4·41 p.p.m. and to give six concentrations of carbon dioxide, in the range 0–240 p.p.m. in each concentration of ammonium chloride; the temperature was maintained at 17·5° C. Ten yearling rainbow trout were placed in each of the eighteen solutions; and their periods of survival were observed. Each test was ended after 12 hr. even if some fish were still alive.

In the absence of ammonia, carbon dioxide was not toxic to the fish within 12 hr. at concentrations up to 30 p.p.m.; 60 p.p.m. carbon dioxide was toxic, however, and the periods of survival decreased as the concentration was increased above this level (Fig. 1). The solution containing ammonium chloride equivalent to 30 p.p.m. nitrogen was markedly toxic when no carbon dioxide was added; but as the concentration of carbon dioxide was increased to 30 p.p.m. the periods of survival lengthened. At concentrations

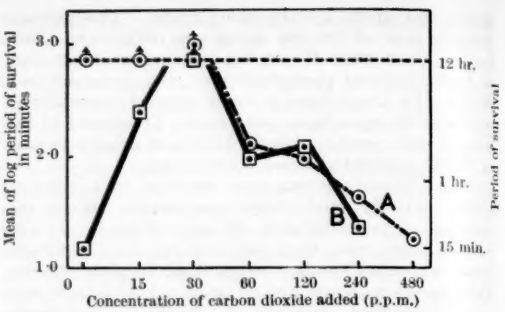

Fig. 1. Toxicity of carbon dioxide and ammonia to rainbow trout. *A*, solutions containing no ammonia. *B*, solutions containing ammonium chloride equivalent to 30 p.p.m. nitrogen

of carbon dioxide between 60 and 240 p.p.m. all solutions were toxic, and there was little difference between the concentration – survival-time curve for carbon dioxide with ammonia and the curve for carbon dioxide alone. Very similar results were obtained with ammonia solutions containing 15 p.p.m. nitrogen.

The results show that the presence of carbon dioxide up to a concentration within the range 15–60 p.p.m. reduces the toxicity of ammonia solutions; higher carbon dioxide concentrations are themselves toxic. It has been shown[1,3] that the toxicity of ammonia solutions to fish is influenced by the *p*H value of the water, because less of the highly toxic un-ionized ammonia and more of the much less toxic ammonium ion is present at a low *p*H value. The *p*H values determined during the experiments with ammonia solutions fell with increasing concentrations of carbon dioxide from about 7·91 when none was added to 7·4 with 30 p.p.m. carbon dioxide and to about 6·9 with 120 p.p.m. carbon dioxide. The calculated amounts of un-ionized ammonia in these solutions were 1·08, 0·26 and 0·10 p.p.m. nitrogen respectively. It is virtually certain, therefore, that the lowering of the *p*H value is a principal, if not the only, cause of the reduction of the toxicity of the ammonia solutions by the addition of carbon dioxide.

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Ergothioneine in the Equine Ampullar Secretion

A striking feature of semen and of the reproductive organs in mammals is the diversity in chemical composition and secretory function encountered among different species[1]. Recent studies on the occurrence of ergothioneine provide a good example of this behaviour. This sulphur-containing nitrogenous base, which has been isolated in a crystalline state from the boar vesicular secretion[2] and which has been

shown to be capable of protecting spermatozoa against the spermicidal action of sulphydryl-binding substances[2], is present in large quantities in the semen of the boar but not in the semen of man, bull, ram or rabbit.

It has been assumed that the rather specific occurrence of ergothioneine in boar semen is linked with the protective (reducing) property of ergothioneine, which may be of particular value to boar spermatozoa in view of the following factors which distinguish the semen of boar from that of most other species: (i) an exceptionally large volume of ejaculate (up to 500 ml.), (ii) low sperm density (less than 100,000 sperm/μl.), (iii) a protracted period of ejaculation (lasting several minutes or even longer), and (iv) a very low level of seminal fructose (a few mgm. per cent). In so far as these four characteristics are concerned, there is some similarity between the boar and another domestic animal, namely, the stallion. Whereas, however, in the boar the bulk of the seminal plasma is produced by the seminal vesicles and bulbo-urethral glands, in the stallion, and also in the jackass, an important contribution is made by the very large ampullæ of the vasa deferentia, which form two well-developed organs, about 20 cm. long and 2 cm. wide. These organs, which have been studied largely by anatomists and histologists[4], have now been found to secrete large quantities of ergothioneine.

In the secretory fluid collected from the ampullæ of stallions, ergothioneine was found to occur in quantities ranging from 14·5 to 115 mgm. per cent, as against 6 mgm. per cent in the vesicular secretion. An even higher content, 63–167 mgm. per cent, has been observed in the ampullar secretion of the jackass, again in contrast to much smaller quantities in the vesicular secretion. These values have been obtained by the use of Hunter's quantitative method, based on the diazo reaction[5]. Additional evidence for the identity of ergothioneine was obtained through chromatographic analysis[3] as well as by the determination of the bromine-labile sulphur[6].

Apart from establishing yet another source of ergothioneine in Nature, the results described here provide fresh evidence that in two different animal species a given chemical constituent of semen need not necessarily arise from the same reproductive gland; thus, in the pig, ergothioneine is found exclusively in the seminal vesicles; but in the horse and ass, much more ergothioneine is produced by the ampullæ than by the seminal vesicles. Once more, it is shown by biochemical methods that anatomically analogous reproductive organs may differ substantially in their specific secretory function.

I am indebted to Dr. T. Mann for his continued help and advice.

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Detoxification of Diphtheria Toxin with Formaldehyde mixed with an Amino-Acid

In the preparation of diphtheria vaccine, the commonly used method involves treatment of the crude toxin with formaldehyde followed by purification of the toxoid by usually rather laborious methods, for example, precipitation at the *iso*electric point with methanol in the cold.

Purification of the toxin before treatment with formaldehyde can be achieved by a relatively simple process. Thus, fractionated salting out with ammonium sulphate yields products of high purity (about 2,000 Lf./mgm. nitrogen). However, the detoxification of the purified toxin raises new difficulties, as the appropriate amount of formaldehyde has to be accurately determined in pilot experiments in order that excessive denaturation and loss of antigenicity may be avoided.

These difficulties can be overcome in the following way. Formaldehyde combines with some amino-acids in a reversible reaction, the equilibrium for some acids being highly in favour of the complex[1]. A mixture of formaldehyde and such an amino-acid will consequently have a low and almost constant concentration of free formaldehyde. Provided that diphtheria toxin reacts only with free formaldehyde but not with the amino-acid – formaldehyde complex, it should be possible to use a relatively large excess of formaldehyde, most of which will be reversibly bound to the amino-acid, and yet to keep the rate of detoxification at such a low level that complete destruction of toxicity may be secured even at 35° C. without appreciable loss of activity (that is, Lf./ml.). Furthermore, in a controlled system of this type reproducible results with different batches of toxin might be more easily obtained. An amino-acid combining with formaldehyde in an irreversible reaction cannot be used. In this investigation glycine (amino acetic acid) has been employed throughout.

Purification of the toxin. Crude diphtheria toxin, obtained by cultivation of the *PW*8 Toronto strain of *Corynebacterium diphtheriae* in Mueller and Miller's medium, was concentrated to one-tenth of the original volume by ultrafiltration. Ammonium sulphate (720 gm. per litre toxin) was added and the *p*H adjusted to 7 with sodium hydroxide. After 15 hr. at room temperature, the precipitate was separated by filtration and dissolved in water. (The filtrate was discarded.) A neutral saturated solution of ammonium sulphate was added to one-third saturation, and the precipitate formed separated by centrifugation. It was then dissolved in water, and again precipitated at one-third saturation of ammonium sulphate. After 15 hr. at room temperature, the precipitate was removed by centrifugation and discarded. The supernatants were pooled and neutral saturated solution of ammonium sulphate was added to 55 per cent saturation. After 15 hr. at room temperature the supernatant was decanted and the precipitate separated by centrifugation. The precipitate was dissolved in water and dialysed against tap water.

The degree of purity of the toxins obtained by this method was 1,800–2,000 Lf./mgm. nitrogen, the yield being 60–80 per cent of the original activity.

Detoxification. 200 ml. 0·5 *M* glycine, 3·5 ml. 40 per cent formaldehyde and 640 ml. water were mixed and the *p*H adjusted to 7 with sodium hydroxide. 156 ml. diphtheria toxin, containing 3,210 Lf./ml.

and having a purity of 2,050 Lf./mgm. nitrogen, were added and the *p*H adjusted to 7·2–7·4. The final concentrations of formaldehyde and glycine were thus 0·05 *M* and 0·1 *M* respectively, the concentration of toxin being 500 Lf./ml. The mixture was kept at room temperature for four days and then at 35° C. for twenty-five days. The *p*H was checked daily during the first week and adjusted when necessary. After twenty-five days at 35° C. the preparation was non-toxic, the activity being 480 Lf./ml. (that is, 4 per cent loss). The flocculation time was twice that of the purified toxin.

For control a mixture of the same composition but without glycine was kept at room temperature for four days and then at 35° C. After four days at 35° C., the activity was completely destroyed.

The toxoid was precipitated with sodium trichloroacetate at *p*H 4·2 [2], dissolved in water, dialysed, sterilized by filtration and adsorbed on aluminium phosphate.

Antigenicity. Half a human dose (that is, 25 Lf.) was injected subcutaneously into guinea pigs of 500 gm. weight. The animals were bled after four weeks. A pool of sera from seven animals contained 2·8 A.U./ml.

This experiment indicates that diphtheria toxin reacts only with free formaldehyde but not with the amino-acid – formaldehyde complex. The antigenic activity of the toxoid obtained was in excess of standard requirements.

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Bacterial Antagonism by *Serratia marcescens*

Arising out of class-work associated with the separation of mixed cultures of *Serratia marcescens* and *Staphylococcus aureus* (*M. pyogenes* v. *aureus*), an inhibitory effect of the *Serratia marcescens* on the *Staph. aureus* has been observed.

The antibiotic responsible differs from that described by Fuller and Horton[1] in several respects. For example, its presence has not been demonstrated in shallow broth cultures of either the usual peptone–'Lemco'–broth or the medium used by Fuller and Horton. Again, using a streak-plate method on peptone–'Lemco'–agar, we have been able to show that the inhibiting zone is a maximum after two days incubation at 30° or five days incubation at 22° (Fig. 1).

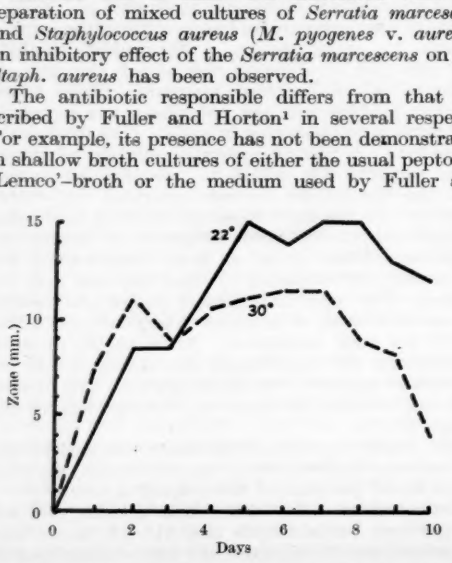

Fig. 1. Inhibition of *Staphylococcus aureus* by *Serratia marcescens*

Organisms sensitive to this antibiotic included *Bacillus megatherium*, *B. subtilis*, *B. mycoides*, *Corynebacterium hoagii*, *Mycobacterium phlei*, *Micrococcus flavus*, *M. roseus*, *M. viscosus*, *Staph. aureus*, *Staph. albus*, *Sarcina lutea*, *Streptococcus lactis* and *Str. faecalis*.

Organisms insensitive to the antibiotic action included *Alcaligenes faecalis*, *A. viscosus*, *Aerobacter aerogenes*, *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas fluorescens*, *Micrococcus tetragenus* and *Streptococcus cremoris*.

Owing to the lack of suitable facilities, it is not proposed to carry the work any further in these laboratories. The strain of *Serratia marcescens* is, however, available to anyone interested in following up the work.

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Progesterone in Human Blood and Tissues

The problem as to whether progesterone is present in human peripheral blood, and in what concentrations, has not yet been solved satisfactorily.

Investigations on the content of progesterone in human blood, made with bioassay methods, have yielded contradictory results. Findings obtained by different methods showed enormous differences of concentration. Hoffmann and von Làm[1] found a maximum of 0·004 γ per c.c. of blood in the luteal phase and a maximum of 0·009 γ per c.c. of blood in pregnancy. Forbes[2] found much higher levels, up to 5·2 γ per c.c. of plasma in the luteal phase and up to 2 γ per c.c. of plasma in pregnancy. On the other hand, hitherto no progesterone has been isolated from peripheral animal[3] or human[4] blood by chemical methods. This led to the conclusion that biological tests are probably lacking in specificity, so that they react upon other substances as well as progesterone.

Considering the great importance of progesterone in the therapy of endocrine disturbances, the solution of this problem seemed indispensable. The development of very sensitive micro-methods permitted an approach to the problem of chemical measurement of progesterone from the experimental side[5,6].

Our method consists of the following steps[6]: extraction of the progesterone and partition in different solvents, isolation by paper chromatography and quantitative determination by ultra-violet spectrophotometric means; definitive identification of these final products with colour-tests, ultra-violet spectra with sulphuric acid and infra-red absorption spectrum. By this method we estimate a maximal loss of 20 per cent. The smallest amount of progesterone which can be detected is 0·05 γ per c.c. blood.

The elimination of the pregnanediol complex has been considered as an indirect criterion of the amount of progesterone produced in the organism. For this reason we considered that the best time for finding

progesterone in the blood would be at the time of highest pregnanediol complex elimination. Therefore, we examined the blood of healthy women from the sixth month of pregnancy onwards. Blood samples of less than 50 c.c. were taken from the cubital vein.

The quantities of progesterone found in these blood samples corresponded approximately to the minima detectable by our method of evaluation. Therefore, the yields from several samples were collected and purified once more by paper chromatography. The ultra-violet absorption spectra in a methanol solution and in sulphuric acid showed the characteristic maxima.

The definitive identification of 61 γ of final products obtained by forty-six single extractions and purified by repeated chromatographies was made by the infra-red absorption spectrum after the method of Schiedt and Restle[7]. The infra-red spectrum showed all the characteristic bands of authentic progesterone. This proves that progesterone is contained in the peripheral blood during the second half of pregnancy.

At this time the average concentration of progesterone in plasma is 0·142 γ per c.c.; converting this value to the corresponding quantity of blood, 0·078 γ per c.c. blood is obtained.

In nine collected extracts made up of four to ten single portions each, a minimum of 0·039 γ per c.c. plasma and a maximum of 0·268 γ per c.c. plasma were found. In the corresponding quantities of blood this represents 0·020–0·151 γ per c.c. blood.

No significant variations of the progesterone concentration in blood were found during the second half of pregnancy.

In order to ascertain the speed of elimination of progesterone from human blood, the variations of progesterone concentration after an intravenous injection of 200 mgm. of progesterone dissolved in a solvent consisting of 40 per cent ethyl-urethane and 40 per cent ethyl-urea were investigated. In menopausal or ovariectomized women, we found 2·540 γ per c.c. plasma at 3–5 min. after injection. This corresponds to 1·443 γ per c.c. blood. Two hours after the injection, progesterone, in a concentration of 0·197 γ per c.c. plasma (0·116 γ per c.c. blood), could still be found. Twenty-four hours after injection, progesterone could no longer be found by our method.

In further studies the organs in which progesterone is produced were examined in order to find out how much free progesterone was present in them. Placentas, corpora lutea, corpus luteum cysts and follicle cysts were studied. All organs were examined *in toto*. The results are summed up in Table 1.

A high concentration of progesterone was detected in a mature Graafian follicle immediately before ovulation. We found 49·4 γ progesterone in 6 gm. follicle fluid with a part of the follicle wall of a twenty-eight year old woman, 14 days after menstruation.

Table 1

Materials examined *in toto*	Contents of progesterone (in γ)
Placenta, pregnancy mens. II–III	61·9
Placenta, pregnancy mens. II–III	51·6
Corpus luteum, pregnancy mens. II	56·1
Corpus luteum, pregnancy mens. II–III	33·5
Corpus luteum, pregnancy mens. II–III	26·3
Corpus luteum cyst (containing 16 c.c. of cystic fluid), pregnancy mens. II–III	21·1
Corpus luteum cyst, pregnancy mens. II–III	17·4
Corpus luteum cyst (containing 7 c.c. of cystic fluid), pregnancy mens. II	17·0
Cystic fluid contained in three follicle cysts from cystic ovary (7·6 c.c.)	7·42
Cystic fluid contained in ovarian cysts from eight women (containing 3·5–265 c.c.)	—

These investigations are being continued, in the hope of determining exactly the amount of progesterone contained in the organs where it is produced, as well as in the blood vessels leading to these organs or issuing from them. The aim is to gain a definite knowledge of the amount of progesterone present during the menstrual cycle and in pregnancy.

I am grateful to Dr. U. Schiedt, Max Planck Institut für Biochemie, Tübingen, for the infra-red absorption spectra, and to Ciba A.G. for the generous supply of progesterone for intravenous injection. This work was supported by a grant from the Deutsche Forschungsgemeinschaft.

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Determination of the Origin of Opium by means of the Composition of the Ash

METHODS of determining the source of opium samples are urgently required as an aid in tightening control measures and suppressing illegal production in those areas of the world where the illicit traffic in opium originates. The Economic and Social Council of the United Nations in 1948–49 authorized research into devising chemical methods of identifying opium, and invited member Governments to participate in such a programme.

Under this programme, work was undertaken in Canada in 1949 on the composition of opium ash. A preliminary spectrographic survey of minor constituents of fifty-seven samples by Lucas and Burgener with statistical evaluation by Dunnet (unpublished results) gave promising results. It was found that, even though opium is produced from one species *Papaver somniferum*, the composition of the ash varies significantly, depending on the geographical origin of the samples.

To extend this work, and to develop the criteria for the identification of unknown samples, the ash of more than a hundred opiums from Yugoslavia, Turkey (two regions), Iran, India, Indo-China, Korea and China has now been analysed for both major and minor constituents. The elements determined were potassium, calcium, phosphorus, sodium, magnesium, silicon, iron, aluminium, titanium, boron, manganese, molybdenum, lead, tin and copper by spectrographic, colorimetric and flame photometric procedures. As an example of the type of composition variation encountered, the distribution of the potassium percentage in the ash plotted against the calcium percentage is shown in Fig. 1.

The results show that, in general, Indian samples have a high potassium and low calcium content in the ash; the druggist type of Turkish opium has a high calcium and a low potassium content, with most other samples being intermediate. The Far Eastern samples have a high phosphorus content relative to the sum of the cations. Within the Far Eastern group the northern sources (China and Korea) produce opiums with a low calcium content and often a low potassium content, while the South-East Asian samples contain more calcium. All Iranian opium ashes studied contain a relatively large amount of tin and copper which, presumably, are introduced during the handling of the raw opium. This feature is very characteristic of Iranian opium. The ash of Turkish soft opium may closely resemble the ash of Yugoslavian and Indian opiums, but can usually be distinguished by the very low silicon and iron content. Yugoslavian opium ash may contain about the same amount of potassium and calcium as some Indian samples; but the percentage of phosphorus is lower. The amounts of the trace metals, boron, manganese and molybdenum, found in opium also vary and may add corroborative evidence to aid in establishing the origin. The criteria for identification have not yet been extended to other opium-producing areas of the world, since insufficient samples of known origin have been available from these areas for developmental work.

Twenty 'unknown' samples of opium were supplied by the United Nations Secretariat for an experiment designed to test the accuracy of the criteria for discrimination of origin based on the ash composition. The origins of these samples were known to the Secretariat but not to us. In the case of several of these samples positive identification could not be made, and two possible origins were quoted in a report to the Secretariat. However, in every case where a single choice was given the origin identified was correct, and in cases where two possibilities were given, one of these two was correct.

The variation in ash composition of opium probably depends on the varieties within the species *Papaver somniferum*, and on such local features as soil, climatic conditions and agricultural techniques. In the case of Iran, the processing of the raw opium has probably contributed to the variation.

The application of the inherent variations in opium ash to the determination of the origin of the raw opium illustrates the usefulness of this technique and its possible application in similar problems of identification.

A full report on this work will be published elsewhere.

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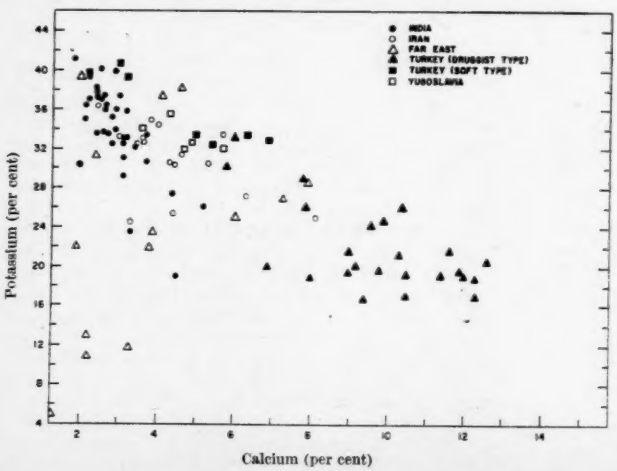

Fig. 1. Scatter diagram showing relationship between per cent calcium and potassium in opium ashes

Test for the Pseudomycorrhizal Group of Soil Fungi

A convenient method has been employed for differentiating between mycelia belonging to the so-called pseudomycorrhizal group, that is, forms of *Rhizoctonia* and *Mycelium radicis atrovirens*, and mycelia regarded as 'trivial' soil fungi which, so far, have not been observed to infect the roots of forest trees.

Cones of filter-paper, cotton-wool and similar cellulosic materials are placed in Erlenmeyer flasks in such a way that they are constantly moistened by capillary rise from the nutrient solution contained in the flasks in which they stand. *Rhizoctonia* and *M. r. atrovirens*, the most common causes of pseudomycorrhizal infection in Great Britain, grow well on these cones, gradually covering them with a dense layer of mycelium. After three to four weeks growth, the cellulose material shows invasion by the mycelium at points where lesions occur in the fibres. Some of the hyphæ penetrating into the lumen of the fibres form large black sclerotia within the central canal, the zones of infection being easily recognized under the low power of the microscope as black, swollen areas. A number of hyphæ, however, traversing through the lumen do not produce sclerotia. After frequent cell divisions, they can be observed to form numerous irregular fusions giving rise to a well-defined structure (Fig. 1) very similar to that of an intercellular net present in pseudomycorrhizal associations of living root tissues. In contrast to the areas affected by sclerotia, the zones exhibiting net structure are of the same diameter as the uninfected parts of the fibres. It would appear that, in these cultural sets, the lumen of the fibres serves as a substitute for the intercellular spaces of the cortical tissues of the tree root.

We have in progress analyses of the factors inducing net formation under these artificial conditions. They indicate that the 'net' infection is mainly dependent on the constitution of the nutrients supplied and the rate of absorption of liquid by the cellulosic material. Beer wort proved to be a most suitable nutrient medium while, for example, potato-dextrose was not successful. Among the cellulosic

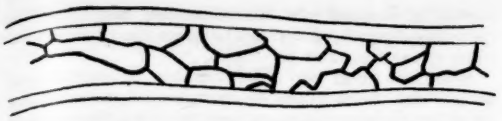

Fig. 1. *Mycelium radicis atrovirens* hyphæ forming a 'net' structure in the lumen of a cotton fibre; drawing by Abbé camera (× 600)

materials employed, cotton fibres were observed to be a good substrate; acetylated cotton cellulose, however, did not encourage net formation.

None of the large number of 'trivial' soil fungi tested, for example, *Alternaria*, *Stemphyllium*, *Pullularia*, *Chaetomium*, etc., although growing vigorously on the surface of the cones, has been observed to produce a net structure within the fibres. Neither was net formation recorded for true mycorrhiza-formers grown under the cultural conditions described.

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Use of Ultra-violet Fluorescent Substances for Observations on Dispersal of *Phytophthora palmivora* Sporangia

OBSERVATIONS have been continued on the take-off of *Phytophthora palmivora* sporangia from cacao (*Theobroma cacao*) pods affected by this fungus. The technique of using 'Vaselined' disks of 'Cellophane' (3 mm. diameter) mounted on pins above the surface of an infected pod has already been described and the take-off of sporangia thereby demonstrated[1].

No information was available as to the number of stray sporangia in the air around a pod. Therefore, the need arose for a method of distinguishing between the sporangia from a particular pod and those which might be merely constituents of what Gregory has referred to[2] as the air 'spora'.

The marking of sporangia was discussed with Dr. A. B. Hadaway, Colonial Insecticide Research Unit, who suggested the possibility of applying a substance such as salicyl aldazine, which fluoresces in ultra-violet light, as a means of recognizing sporangia from a particular source. Tests were started in which a saturated solution of salicyl aldazine in water was sprayed on to the sporangia-bearing surface of an affected pod in the field. Disks were then placed above the pod as already described. The disks were afterwards examined under the microscope with an illumination source rich in ultra-violet light. Preliminary attempts were unproductive, apparently because salicyl aldazine is insufficiently soluble to give an adequate deposit on the sporangia *in situ*. It seemed desirable to use a more soluble substance in order to obtain a greater concentration on the sporangia. However, before the use of salicyl aldazine was abandoned, this substance was applied to sporangia in the dry form, using a small hand bellows. Later, when the disks were examined, a few sporangia were found with particles of salicyl aldazine adhering. This procedure suffered from the disadvantage of introducing an extremely artificial condition, in that the take-off and dispersal of a sporangium would be affected in an unknown way by the accompanying particle. In seeking a suitable soluble substance for use in these studies, I am greatly indebted to Mr. J. A. Radley, Industrial Research and Development Laboratories, Reading, who suggested and supplied samples of three substances (primuline *A*.150 (I.C.I.) (C.I. No. 812); rhodamine 6 *GDN* 500 (I.C.I.); stilbene derivative) for trial in Nigeria. In the course of preliminary but not exhaustive tests, it was decided that primuline *A*.150 would be the most suitable of the three substances supplied. It was used exclusively in further experiments and is later referred to here as primuline, for the sake of brevity. This substance is soluble in water (5 per cent by weight at 30° C.) and gives a greenish-yellow fluorescence. When a saturated solution was sprayed on to sporangia *in situ*, they were readily stained by the primuline and became very conspicuous in ultra-violet light. Incidental observations indicated that primuline did not exert any toxic effect.

Sporangia showing the characteristic primuline fluorescence have been observed on disks exposed in rainless periods when take-off apparently occurred in 'dry' air. The number of sporangia per disk has averaged 0·3 per 12-hr. period. Larger numbers of sporangia (average 1·4 per disk per 12-hr. period) were observed on disks exposed during periods when rain fell, suggesting that rain-splash take-off had occurred. It has already been suggested that sporangia are commonly dispersed in splash-droplets[1]. Non-fluorescent sporangia were observed on some of the disks examined; these sporangia may have come from the air 'spora'; but it is also possible that they may have been sporangia from the primuline-treated pod which had escaped treatment.

The procedure used for these observations on dispersal of *Phytophthora palmivora* by marking sporangia with primuline has served satisfactorily to confirm the phenomenon of take-off in 'dry' air. It is possible that this technique can be usefully applied to similar studies with other fungi. Detailed results will be published elsewhere.

This communication is published with the permission of the Inspector-General of Agriculture, Nigeria. I am indebted to Imperial Chemical Industries, Dyestuffs Division, for information on the solubility and fluorescence of primuline *A*.150.

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Somatic Selection in Fungi

IN a recent communication, Calpouzos[1] reported that prolonged selection of sporulating material from recent single or mass spore isolates of the fungus *Cercospora musae* gradually increased the intensity and uniformity of sporulation in later cultures even though the spores selected were always of asexual origin. He suggested that if the original isolates had been heterokaryotic this observation was in agreement with the gradual sorting out, by selection, of a nuclear type having a greater spore-producing potential. Although this is a possibility in the case reported by Calpouzos, a similar situation has been

encountered in my own experiments under conditions where heterokaryosis is ruled out as a possible explanation.

A normal culture of *Aspergillus nidulans* has both asexual conidia (which are always uninucleate) and sexual ascospores. Transfers may be made by conidia, ascospores or hyphal tips. In the course of routine maintenance it was noted that after a few transfers by single conidia the formation of perithecia became progressively delayed and infrequent; until after the fourteenth transfer no perithecia were produced. Since this fourteenth transfer the line has remained asexual for more than a year. After the fifth and ninth conidial transfers, however, single ascospores were used for starting new cultures. In these sub-lines germination of ascospores was initially poor; but after several generations of transfer by ascospores, germination and perithecial formation improved until the lost characteristics of the normal culture had been regained.

A series of transfers by single ascospores for the ascosporal line, made in parallel with the conidial transfers, led to a marked decrease of asexual spores. From the third and ninth generations of this line, sub-cultures were repeatedly transferred by single conidia, and the sub-lines also regained the normal balance of sexual and asexual spores. Thus a change occurred in these two lines in the direction of the method of propagation (sexual or asexual) used, and it was reversible by reversal of the method of propagation. In the asexual line the gradual change reached its extreme in an irreversible change to an *imperfect* form.

An observation probably related to that in *Aspergillus* was made on homokaryons derived from recently isolated heterokaryons of *Penicillium cyclopium*[2], which is known only in the asexual form. In this case colonies arising from single uninucleate conidia varied in their sporulation, the more fertile arising disproportionately often from spores formed early in the life of the parent mycelium. Transfer by hyphal tips or sterile aerial mycelium appeared to lead to a delay in sporulation if not to a real decrease in the number of spores. On the other hand, parallel cultures obtained by continuous transfer through single conidia resulted in a gradual increase in the intensity of sporulation. The changes were found to be reversible whenever tested.

In a preliminary investigation into the inheritance of the difference in *A. nidulans* an autonomous yellow spore mutation was introduced into the ascospore selected line with sparse conidia, and a heterokaryotic association formed between this marked line and the conidial-selected line[3]. The newly formed heterokaryons sporulated freely, giving both green and yellow conidia. They also gave a normal number of perithecia, some of which originated from the mating of two nuclei from the sexual type parent (being recognized by their giving progeny all with yellow conidia), some from the fusion between nuclei from the sexual and from the asexual type parent (which gave mixed progenies with yellow and green conidia), but some also from the fusion of two nuclei from the asexual type parent (which gave only progeny with green conidia). All spores, whether green or yellow, sexual or asexual, gave mycelia with a normal ratio of conidia and perithecia. Thus, not only are the nuclei of the asexual type parent capable of giving the full range of development in the cytoplasm of the heterokaryon but they are still capable of doing so following their extraction from the heterokaryon by means of asexual conidia. We can only conclude, therefore, that the difference between the two selection lines is extranuclear in origin.

Since in fungi all cells, capable of reproducing at all, can form complete organisms and in doing so generally give identical results, the differentiation between ascogenous hyphæ, conidiophores and vegetative mycelia must be due not to the nucleus but to the condition of the cytoplasm in the differentiating region. The normal nucleus is capable of determining and responding to the full range of differentiating cytoplasm so that a full range of organs is produced; but mutated nuclei are known which fail to give this full range, as, for example, where non-sporulating forms are produced (Pontecorvo and Gemmell[4], Sansome[5], Hansen and Snyder[6]). That the differences in *A. nidulans* considered above are not of this nuclear kind is shown by the ability of a nucleus originally of a non-sexual type to give the full range of development when present in the cytoplasm of the heterokaryon. The failure of differentiation must reside in the cytoplasm. Now cytoplasmic differences can arise from chance irregularity in distribution of self-reproducing bodies, or from environmental changes or from nuclear action. In higher organisms, nuclear genes play the predominant part in differentiation by their orderly control of cytoplasmic change. In the present case to relate the progressive and reversible changes in spore frequencies to nuclear differences would be to imply a progressive and reversible rate of mutation of a very unlikely kind. It is much more likely that in both species the changes were due to changes in the cytoplasm that perhaps spring from non-random distribution of its components. This could arise by differential multiplication under environmental stimulus (relatable perhaps to staling of the medium) or as a normal outcome of differentiation. Irrespective of the origin of these cytoplasmic differences, as a result of the selection practised here, they have been progressively built up until larger, more permanent differences such as distinguish tissues in higher organisms have been attained. It would seem that one difference between fungi and most higher organisms lies in the less effective co-ordination of cytoplasmic changes, that is, the less rigid control of the cytoplasm by the nucleus in the fungus. Even so it would appear that cytoplasmic differences can be built up and broken down by somatic selection in rotifers[7] and *Lemna*[8], so that the control of the fungus is related to changes in higher organisms. The information to be gained from the fungus would thus appear to be of potential value to our understanding of the process of differentiation in general.

I am indebted to Prof. K. Mather and Mr. L. G. Wigan for helpful discussion in the preparation of this report.

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Prolonged Stimulation of Wool Growth following Injections of Ox Growth Hormone

During an investigation of the pituitary regulation of wool growth, various ox anterior pituitary preparations were injected into normal sheep. The sheep were individually fed a constant weighed ration, and wool growth was measured by clipping an area of 20 cm. × 20 cm. defined by tattoo lines on the midside of the body at weekly or fortnightly intervals. The wool samples were extracted to remove ether-soluble and water-soluble grease, * and the oven-dry weight taken as a measure of wool growth over the period between two successive clippings.

In the first experiment, four ewes (two Romney Marsh and two Suffolk) were each injected with 4 ml., daily for fourteen days, of an alkaline saline extract of ox anterior pituitary glands (*F.G.S.* 289) prepared as described by Young[1] and Reid[2]. Four ewes (two of each breed) were maintained as controls. Wool growth was measured over two preliminary periods of fourteen days each prior to commencing injections. Wool growth thereafter was expressed as a percentage of the corresponding mean value for the preliminary period. During the first week of injections, wool growth in the treated group was significantly ($P < 0{\cdot}01$) increased by 17 per cent above that of the controls. A reverse effect was seen during the second week of injections, the wool growth of the treated group being 14 per cent below that of the controls. This effect was not significant, one of the control sheep being sick during the week and showing a depression of wool growth. The value for this sheep was omitted from the comparison. After the cessation of injections, wool growth of the treated sheep significantly ($P < 0{\cdot}05$) increased relative to the controls, the difference reaching nearly 30 per cent fourteen weeks after the cessation of injections, and gradually disappearing over the next ten weeks. There was no significant difference between the two breeds in their responses to treatment. The pituitary extract used was rich in growth hormone but also contained prolactin, thyrotrophic hormone and luteinizing hormone in good amounts.

In another experiment with ewes of the same breeds, four ewes were injected daily with 5 mgm. of ox growth hormone (24 *GH*) for five weeks. The effect on wool growth is shown in Fig. 1. Wool growth in treated ewes of both breeds increased relative to the controls throughout the period of injections ($P < 0{\cdot}01$) and continued above the control-level for twenty-nine weeks after the cessation of injections ($P < 0{\cdot}01$) when the experiment was terminated. The stimulation of wool growth was greater in the Suffolk than in the Romney Marsh ewes both during and after the injection period.

When similar experiments were carried out with Lincoln ewes, a stimulation of wool growth was observed during the period of injections of both anterior pituitary extract and growth hormone; but the response disappeared soon after the cessation of injections except in three ewes (two out of twelve ewes injected with anterior pituitary extract, and one out of eight injected with ox growth hormone). One cannot be sure, of course, that their individual responses were, in fact, due to the treatment.

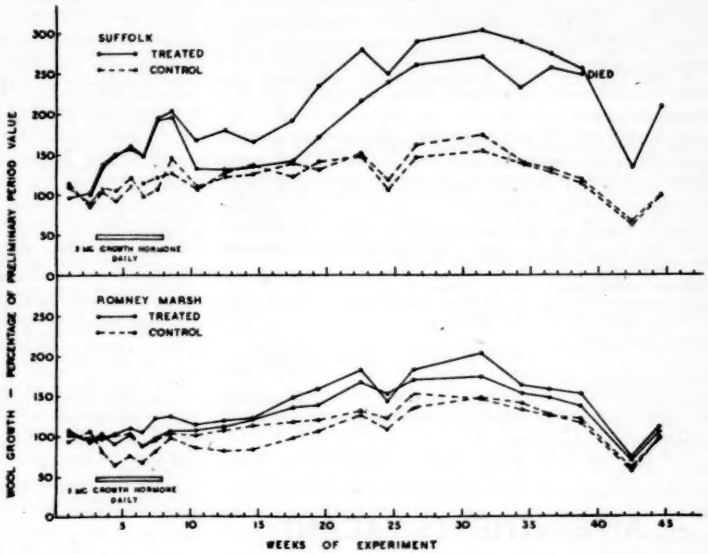

Fig. 1

It was postulated that the prolonged responses of wool growth recorded with the Romney Marsh and Suffolk ewes were due to an immune-type reaction resulting in an increase in the secretion of growth hormone by the sheep's own pituitary or a decrease in its rate of destruction. The sera of the injected sheep were accordingly tested for antibodies to ox growth hormone by the tannic acid hæmagglutination reaction[3]. The results of these tests have been described elsewhere[4]. Antibodies to ox growth hormone were detected in the sera of sheep showing prolonged responses of wool growth. The titre was not correlated with the size of the wool response, but too few observations were available to estimate the correlation with accuracy. More work is in progress to test the hypothesis further.

I am indebted to Dr. E. Reid for his collaboration in the preparation of the pituitary extracts used in the above experiments.

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[4] Ferguson, K. A., and Boyden, S. V., *J. Endocrinol.*, **9**, 261 (1953).

FORTHCOMING EVENTS

Wednesday, September 1st—Wednesday, September 8th

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Oxford).—Annual Meeting.

Wednesday, September 1

At 8.30 p.m.—Dr. E. D. Adrian, O.M., F.R.S.: "Science and Human Nature" (Presidential Address).

Thursday, September 2

At 10 a.m.—Sir John Cockcroft, F.R.S.: "Recent Developments in Nuclear Physics" (Presidential Address, Section A).
At 10 a.m.—Sir John Lennard-Jones, F.R.S.: "New Ideas in Chemistry" (Presidential Address, Section B).
At 10 a.m.—Sir Gavin R. de Beer, F.R.S.: "Archæopteryx and Evolution" (Presidential Address, Section D).
At 10 a.m.—Prof. W. H. Pearsall, F.R.S.: "Growth and Production" (Presidential Address, Section K).
At 11.45 a.m.—Prof. L. S. Hearnshaw: "Recent Studies in the Psychology of Thinking" (Presidential Address, Section J).
At 2.30 p.m.—Dr. C. B. Williams, F.R.S.: "Phenology—The Study of the Seasons" (Presidential Address, Section X).

Friday, September 3

At 10 a.m.—Prof. E. A. G. Robinson: "The Changing Structure of the British Economy" (Presidential Address, Section F).
At 10 a.m.—Dr. Willis Jackson, F.R.S.: "The Effect of New Materials on Engineering Progress" (Presidential Address, Section G).
At 10 a.m.—Sir Mortimer Wheeler: "Colonial Archæology" (Presidential Address Section H).
At 10 a.m.—Mr. Ronald Gould: "The Teacher in the Twentieth Century" (Presidential Address, Section L).
At 10 a.m.—Dr. R. E. Slade: "Agriculture—The Industry and the Science" (Presidential Address, Section M).
At 11.30 a.m.—Prof. J. A. Steers: "The Coast and the Geographer" (Presidential Address, Section E).
At 8 p.m.—Prof. W. E. Le Gros Clark, F.R.S.: "Reason and Fallacy in the Study of Fossil Man".

Sunday, September 5

At 8 p.m.—Prof. C. A. Coulson, F.R.S.: "Science and Religion".

Monday, September 6

At 10 a.m.—Dr. C. J. Stubblefield, F.R.S.: "The Relationship of Palæontology to Stratigraphy" (Presidential Address, Section C).
At 10 a.m.—Prof. A. D. Macdonald: "The Relief of Pain" (Presidential Address, Section I).
At 8 p.m.—Dr. F. P. Bowden, F.R.S.: "Friction".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ADVISORY OFFICER (with an honours degree in agriculture or pure science, and a special interest in grassland work) IN AGRICULTURAL BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (September 4).

ASSISTANT, Grade A (with graduate or equivalent qualifications), at Sheffield College of Commerce and Technology, to teach physics in National Certificate Courses in Chemistry and Metallurgy, in advanced level classes for the general certificate of education, and in various City and Guilds courses—The Director of Education, P.O. Box 67, Leopold Street, Sheffield (September 4).

ASSISTANT LECTURER IN METALLURGY—The Registrar, The University, Manchester 13 (September 11).

CHEMISTS (with a first- or second-class honours degree or equivalent in chemistry, and with research experience, preferably in physical chemistry), with the Ministry of Supply at various research stations mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.546/54A (September 11).

RESEARCH DEMONSTRATOR IN GEOGRAPHY—The Registrar, The University, Sheffield (September 11).

RESEARCH OFFICER (with an honours degree in engineering or science or equivalent qualifications) IN THE DIVISION OF BUILDING RESEARCH, Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, to participate in a programme of theoretical and experimental research on the properties and uses of lightweight concrete and gypsum plaster as structural materials—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 390/209 (September 18).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university degree in veterinary science, with postgraduate research experience in the control of animal diseases or equivalent qualifications) AT THE ANIMAL HEALTH RESEARCH LABORATORY, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, to undertake the general responsibilities of a veterinary pathologist and bacteriologist in laboratory and field investigations, and to develop an individual interest in one of the research projects—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 201/81 (September 18).

LECTURER IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (September 20).

LECTURER (graduate, with qualifications and/or experience in measurements and/or heavy electrical engineering) IN ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (September 22).

LECTURER IN DRESSING OF MINERALS AND COAL PREPARATION—The Registrar, The University, Leeds 2 (September 27).

LECTURER or ASSISTANT LECTURER (with an honours degree in physical oceanography, mathematics or physics, and prepared to spend several weeks each year at sea) IN THE DEPARTMENT OF OCEANOGRAPHY—The Registrar, The University, Liverpool (September 30).

CHEMIST or METALLURGIST (with a first- or second-class honours degree or equivalent in chemistry or metallurgy, and with post-graduate research experience, particularly concerning the study of corrosion), with the Ministry of Supply, Port Harcourt, Nigeria, to study the effects of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F564/54A.

PHYSICIST (with a first- or second-class honours degree in physics and considerable experience of instrumentation research and development) IN THE ROCKET PROPULSION DEPARTMENT, Ministry of Supply, Westcott, Bucks, to lead a small section on rocket instrumentation research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting 235/54A.

RESEARCH ASSISTANT in the field of Physical Chemistry (reaction kinetics)—The Secretary, University College, Exeter.

SCIENTIFIC ASSISTANT (with a degree in agriculture or natural science, a knowledge of languages, and ability to write clear concise abstracts in English), for duties which will mainly consist of examining and abstracting world scientific literature on grassland and field-crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry or equivalent qualifications, and a sound theoretical knowledge of inorganic and physical chemistry, and experience of modern methods of inorganic analysis), at the Capenhurst Works of the United Kingdom Atomic Energy Authority, near Chester, to carry out research and development work on analytical methods—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 650.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics with subsidiary mathematics, and preferably with some knowledge of electronics), at Fort Halstead, Kent, for experimental small-scale work on fundamental problems in connexion with the study of phenomena associated with explosions—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 209/WGE./2.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in engineering, physics or mathematics or equivalent qualifications) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, for research in several branches of mechanical engineering, for example, fluid mechanics, heat transfer, lubrication and improvement of mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.551/54A.

SENIOR TECHNICIAN IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology, for the year 1953, with Report of the Geological Survey Board and Report of the Director. Pp. iv+90. (London: H.M. Stationery Office, 1954.) 3*s*. net. [17

Forestry Commission. The Queen Elizabeth Forest Park: Ben Lomond, Loch Ard and the Trossachs. Edited by Dr. John Walton. Pp. vii+80+1 map. (London: H.M. Stationery Office, 1954.) 3*s*. 6*d*. net. [17

Forestry Commission. Traps for Grey Squirrels. Pp. 9. Forest Record No. 26: Drought Crack of Conifers. By W. R. Day. Pp. 40 (10 plates). 2*s*. 6*d*. net. Forest Record No. 27: Use of Home-Grown Timber in Wood Turning and Related Trades in Scotland in 1953. By J. R. Aaron. Pp. 10+4 plates. 1*s*. 3*d*. Forest Record No. 28: Volume Table for Small Hardwood Trees. By J. N. R. Jeffers. Pp. 10. 9*d*. net. (London: H.M. Stationery Office, 1954.) [17

Other Countries

World Health Organization. Technical Report Series No. 83: Methodology of Planning an Integrated Health Programme for Rural Areas. Second Report of the Expert Committee on Public Health Administration. Pp. 46. 1*s*. 9*d*.; 0.25 dollars; 1 Swiss franc. Technical Report Series No. 85: First International Conference of National Committees on Vital and Health Statistics. Report. Pp. 22. 1*s*. 9*d*.; 0.25 dollars; 1 Swiss franc. Technical Report Series No. 86: Expert Committee on Biological Standardization. Seventh Report. Pp. 22. 1*s*. 9*d*.; 0.25 dollars; 1 Swiss franc. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) [57

Smithsonian Miscellaneous Collections. Vol. 120 (Whole Volume): Smithsonian Physical Tables. Ninth revised edition. Prepared by William Elmer Forsythe. (Publication 4169.) Pp. vi+827. (Washington, D.C.: Smithsonian Institution, 1954.) 9 dollars, paper; 10 dollars, cloth. [57

United States Department of Agriculture. Farmers' Bulletin No. 1829: Insects and Diseases of the Pecan and their Control. Pp. 56. (Washington, D.C.: Government Printing Office, 1954.) 25 cents. [57

United States Naval Observatory. Circular No. 51: Positions, Areas and Counts of Sunspots, March–April, 1954. By Dr. Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: U.S. Naval Observatory, 1954.) [57

SOCIAL RESPONSIBILITY IN THE MODERN WORLD

RECENT presidential addresses to the British Association have frequently considered the impact of science on society—generally an aspect of that impact which the president could discuss with special authority—and have sought to indicate to the layman some implications of the advance in knowledge and technique for the world to-day. That responsibility is frankly accepted by this year's president. Dr. E. D. Adrian, whose address is printed on p. 433, believes that the Association should show the layman where the scientific age is leading him and that the success of the Association's meetings is to be judged by its impact on public opinion.

The theme of Dr. Adrian's address, however, is not so much the impact of science on society, as its impact on man himself. To appreciate the difference it is unnecessary to look back so far as Dr. Adrian himself did, to the famous meeting of 1860 which, as he pointed out, emphasized both that man himself is part of the physical world and also man's determination to go on searching for truth—a determination which has been sternly challenged even in the West during the past twenty years. We need look no further than the meeting at Oxford just sixty years ago. At that meeting, at which, in his presidential address, the Marquis of Salisbury referred particularly to our ignorance of the nature of atomic structure, of the ether, and of the causes and origins of life, Sir Oliver Lodge gave the first public demonstration of wireless signalling by means of electromagnetic waves, and Lord Rayleigh and Prof. William Ramsay gave a preliminary account of a new gaseous constituent of the atmosphere. The isolation of argon and helium and the other rare gases still lay in the future, with Becquerel's discovery of radioactivity. Even when next the Association met at Oxford in 1926, although Rutherford had indicated the possibility of atomic fission at a price, the discovery of the neutron lay half a dozen years ahead. Atomic physics and radiochemistry were still to develop, and even broadcasting was a relative novelty which had yet to exert its full power over the mind and habits of society.

On any comparison of the impact of scientific discovery and its applications on society between the meetings of the Association at Oxford in 1894 and 1926, and between that of 1926 and the present, the changes in habit, in opportunities for good and for ill have been far more profound in the second period. As Dr. Adrian pointed out, in atomic physics we face discoveries which could be used to devastate half the world, and if so applied would at least make life in the other half extremely precarious. Moreover, the direct effects of atomic explosions, though of chief concern to the strategist, are not the only dangers: repeated atomic explosions might lead to a degree of general radioactivity which no one can tolerate or escape. The dangers of contamination associated with the supply of atomic energy for industrial use can be avoided by suitable precautions; but in a major war such precautions would soon be set aside, if indeed they could be organized effectively. Dr. Adrian is almost certainly right in suggesting that a long war between powers well armed with atomic bombs would involve an order of radioactive contamination which neither victors nor vanquished could escape.

This additional risk of catastrophe does not, he argued, make our predicament much worse than that of earlier generations. Our predicament is the inevitable result of our curiosity and of the physical nature of the world in which we live; but if we can make our behaviour worthy of our increased knowledge, we can live safely. In other words, scientific advance has imposed on man the need for standards of conduct and forms of social organization which are appropriate for the new powers which are put into man's hands and the changed conditions under which he has to live. If man is to use wisely and safely the immense powers now at his command, he must accept the discipline that such use demands and adapt himself and his institutions accordingly.

Advances in atomic physics are not the only advances in science which make such demands on man. Advances in medical science can be misapplied, and drugs can be used for subduing men's minds as well as for the relief of pain and the cure of disease. Prof. A. V. Hill two years ago pointed to some of the implications of the eradication of disease in the way of social discipline for the backward areas of the world; and, as Dr. Adrian reminds his audience this year, a drug or a system of education which would make us all do as we are told, a method of producing radical conversion to a new system of belief or a knowledge of new ways of rousing patriotic ardour, could all be used with consequences as grim as the genetical deterioration in a radioactive world. The psychiatrist who discovers a cure for paranoia may find he has also revealed a convenient way of producing it.

How precarious is the division between the beneficial and harmful effects of any particular discovery has been emphasized by Mr. Charles Morgan and other modern novelists; and it cannot be too firmly insisted that if we continue to tolerate war, there is no kind of scientific investigation which might not be used for making war more destructive, no discovery in the field of human conduct which could be guaranteed harmless. The alternative to social discipline is, in fact, the renunciation of the whole process of discovery and investigation. To rely on increased knowledge for defence as well as attack is more likely to postpone than avert catastrophe, and the core of Dr. Adrian's address lies in his plea for the individual and social readjustment which these grave possibilities demand as a condition of the continuance of civilization.

The scientist, said Dr. Adrian, has a dual responsibility. He must apply his science to learn as much as possible about the mental and physical causes of our behaviour, and he must study human nature to